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SOME RUBBER ESTATE MIXTURES.

Many of the rubber estates in Ceylon have special mixtures of artificial manures, the composition of which is not as a rule made public. They may be applied yearly or in alternate years with or without an alternate mixture. As their composition is generally the outcome of experience on the part of the Visiting Agent or Superintendent or of advice obtained from a manure firm it may be worth while studying their composition to ascertain whether some underlying principles can be detected running through them. We have been examining eight such mixtures from the Central, Southern, and Western Provinces and tabulate their contents below. For obvious reasons we substitute numbers for the names of the estates or groups. The quantities are lbs. per acre.

	1	2	3	4	5	6	7	8
Ground Nut Cake	300	100		600		400	300	
Castor Cake ...					400			
Blood Meal ...	80	40				100	50	
Fish Guano ...						200		
Crushed fish ...	220	150						
Peruvian guano ...								200
Sulphate of Ammonia ...	60	40	300			75		
Nitrolim ...							100	
Superphosphate of Lime ...	60						50	
Concentrated superphosphate		25	75					
Basic slag ...				100	200			
Steamed bones ...						100		
Sulphate of Potash	80	25	180	100	150	125	100	
Analysis.								
Nitrogen ...	52·9	26·75	60	42	20	73	45·25	10
Phosphoric acid...	19·6	16·50	31·5	20	40	38	9	20
Potash ...	40	12·5	90	50	75	62·5	50	4

From the last three lines in the table, under analysis, it will be seen that the mixtures differ considerably from one another in composition. Taking phosphoric acid in each case as 100, we have the following ratios:

	1	2	3	4	5	6	7	8	Mean
Nitrogen ...	269	162	190	210	50	192	502	50	203
Phosphoric acid ...	100	100	100	100	100	100	100	100	100
Potash ...	204	75	285	250	187	164	550	20	216

We are as yet without data to enable us to determine which of the ingredients if any should be considered the dominant manure for Hevea rubber, or in what proportions generally speaking the ingredients should be mixed, though experiments to determine these points have been in progress for two years at Peradeniya, and some definite results should soon be available. We must, therefore, seek some other standard with which to judge of the various proportions that are in these cases employed. For this purpose we may take fresh cow dung, one of nature's manures, which has about 0·34 per cent. of nitrogen, 0·16 per cent. of phosphoric acid and 0·40 of potash. Calculated for 100 parts of phosphoric acid we have the following proportions:—

Nitrogen	212
Phosphoric acid	100
Potash	250

Referred to this standard the proportion of phosphoric acid in No. 1 and notably in No. 7 is low; Nos. 2, 3, 5, 6 and 8 have a deficiency of nitrogen, and Nos. 1, 2, 5, 6 and 8 a deficiency of potash. No. 4 conforms most nearly to the natural manure.

We have not before us any soil analyses of these estates; and if we had we should probably find that the soil on each estate showed considerable variation; but the composition of the soil should always, of course, be studied when mixtures are made up. It will serve our purpose to examine the analyses of a list of twenty-five Ceylon estate soils reported on some years ago by MR. KELWAY BAMBER, the Government Chemist, and published in RUTHERFORD'S Note Book. Following are details of the average percentage of some of the ingredients of these soils, the

highest and the lowest that are found in any of them, and the composition of a typical loamy soil in England:

—	Organic matter and combined water %	Nitrogen %	Phosphoric acid %	Potash %	Lime %
Average	10·433	0·165	0·070	0·142	0·185
Highest	15·910	0·331	0·169	0·328	0·608
Lowest	5·860	0·079	0·024	0·039	0·008
Typical Loam	5·660	0·170	0·380	0·80	1·280

With regard to nitrogen the average percentage in these soils compares favourably with that of a typical fertile, loamy soil in England, but the proportion of phosphoric acid, potash and lime is low; especially of phosphoric acid, which is about twenty per cent. of that of the loam. Even the soil richest in phosphoric acid is still deficient judged by this standard. In the light of these figures we should have expected to find phosphoric acid filling a larger place in Ceylon mixtures than it appears to do. The soils show up better in potash but are yet not rich in these constituents.

A feature of these Ceylon soils is their richness in organic matter and combined water and poverty in lime. These may be taken together because lime reacts on the acidity caused by organic matter and tends to release the locked up plant food. The average percentage of lime is only 14·4 per cent. of that of the loam; the Ceylon soils possess on an average an excess of organic matter. This being the case, the application of lime should find an important place in any general scheme of manuring rubber in Ceylon.

R. N. L.

GREEN MAIZE FOR MILKING.

Green maize, if fed to milking cows before it shows the tassel, will do no injury, but it must be remembered that the greatest amount of nutriment is contained in maize when the cob is turning from the milky into the glazing stage. This, however, does not apply to any of the Sorghum family, such as Sorghum Saccharatum, Planter's Friend, and Amber Cane. These must on no account be fed to cattle unless in the flowering stage, or unless they have been allowed to wilt; that is to say, Amber cane cut in the morning can be fed in the evening or if cut in the evening can be fed the following morning without any danger to the stock.—THE AGRICULTURAL NEWS (DURBAN).

COCONUTS.

THE GERMINATION OF THE COCONUT.

In the JOURNAL OF HEREDITY for April last is to be found the result of a most interesting study of this phenomenon by MESSRS. COOK and DOYLE of the U. S. A. Department of Agriculture.

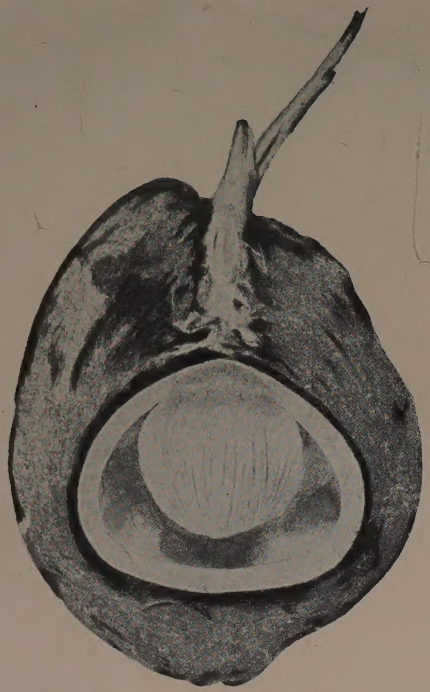
The article opens with the laconic remark that "Coconuts are seeds," but as the term coconut is applied in the article itself to the nut with the husk on, the statement is somewhat misleading. In reality the coconut is a drupe or stone-fruit, in which the stone is enveloped in a fibrous mesocarp. The true seed lies within the hard woody endocarp or shell of the so-called "nut," which by the way is again a misnomer.

The authors dispute the theory of maritime distribution, maintaining that the coconut is neither a sea-shore plant by nature nor dispersed by the sea. In support of their contention they state that the same type of husk which characterises the coconut and leads people to believe that it is intended to float in water, is found in many other species of palms which do not grow on the sea coast and are known never to be distributed by water: while the waxy coating on the husk (believed to be a water-proof material) is common to all palms and found specially well-developed in many inland species.

In spite of the coconut being so abundant and of such economic importance in the Pacific Islands, there is according to the authors nothing to show that its habits enable it to exist permanently or in a truly wild state in a littoral or oceanic environment. The common belief of its being a native of this region is stated to be contrary to the opinions of those who have studied the palm as it grows in the Pacific Islands. These authorities are of the view that there are no wild coconut palms in the Pacific, that it has everywhere been actually planted by man, and that the palm does not survive human neglect for any period.

It is argued from the store of water in the interior, the large supply of solid endosperm and the thick fibrous husk, that the native habitat of the coconut must have been a relatively dry clime where the plant had to grow to a fairly large size before it could draw upon soil moisture: while on the other hand such provision would seem unnecessary in a maritime plant. The great size of the nut would indeed be a disadvantage in this latter situation as preventing it from being buried in the sand. The palms that are known to live on the shore have small seeds. We must, therefore, according to the authors, think of the coconut as an interior palm growing in an alkaline soil and subject to prolonged droughts, in order to appreciate the significance of its large seed, its copious supply of endosperm and water and thick spongy husk capable of absorbing moisture when brought within reach of it. As is generally known the coconut is also intolerant of shade, and this points to its original habitat being a region where other vegetation was absent or very sparse.

Going back to the husk, one cannot fail to notice its suitability as a medium for starting the growth of roots. Indeed the coconut may be likened



A

B

C.

THE GERMINATION OF THE COCONUT.

A. Longitudinal section of germinating nut showing Cotyledon or "nursing foot." (Reduced).

B. Coconut seedling removed from shell showing narrow "neck" between the cotyledon and the sprout through which the nourishment is carried. (Natural size).

C. Dried coconut sprout, with the cotyledon removed, showing the fibres that arise in the cotyledon and pass through the neck into the base of the young plant. These fibres probably serve to convey nourishment to the sprout. (Enlarged about 2½ diameters).

to "a self-potted plant," and the hanging up of coconuts till the whole process of germination is complete, and the green plant has appeared is a fairly common practice which supports this view.

A remarkable thing about the coconut is the small size of the embryo or living germ in comparison to its other parts. It is a tiny cylindrical body lying just beneath the largest eye in the shell. When germination begins the embryo elongates and enlarges at both ends. From the outer end arise the young stem and roots, while internally is formed a large spongy mass called the cotyledon through which are scattered vascular stands which converge and become fibrous at the narrow neck connecting the spongy mass with the stem.

The function of the cotyledon is to convey the food material derived from the solid endosperm to the seedling plant. In order to be absorbed this material has to be digested under the influence of the ferments secreted by the cotyledon and passed into the water contained in the central cavity.

The fluid-filled cavity would in addition to its storage function appear to play the part of a stomach to provide for the digestion and absorption of food material stored in the solid endosperm. In this way the milk would be periodically recharged with food materials to replace those absorbed by the cotyledon.

It is unnecessary to follow the various changes in composition of meat and water which take place as the process of germination goes on.

We would direct attention to the illustrations accompanying this summary of a most interesting paper. They are selected from a number of excellent photo. reproductions which appeared with the original article in the JOURNAL OF HEREDITY, to which periodical we duly acknowledge our indebtedness.

C. D.

LOCUSTS.

Noakhali Plantation,
Akyab (Burma),
The 15th April, 1916.

To the EDITOR of the TROPICAL AGRICULTURIST,
Peradeniya, Ceylon.

SIR,—Will you, or any Ceylon coconut planter be good enough to let me know through your valuable journal the most effective method of diminishing the pest of locusts which do considerable damage to the trees here? They breed near small shrubs during February and March, and by the time the rains begin in May they are full grown. They attack chiefly the younger trees from two to five years, and they are always found in such large numbers on the trees, that the trees appear a black mass. They do not take long in their work as they ruin a tree in a few hours. We have used Lead Arsenate on the trees to prevent their attack, but this did not prove beneficial as the rains washed the solution off.

I shall be glad to know of any means of exterminating this pest if possible.

(2). The coconut beetle found here is the *Oryctes Rhinoceros* which do the most damage. They attack young and old trees alike and are most abundant during the hot season. We employ men to search for the beetles on the trees and at the same time clear the trees of all dead leaves and rubbish

and apply a solution of tar to the parts attacked. We have found this most effective, and the clearing of the trees too have helped them a good deal. The trees are now looking quite fresh, and the crops have almost doubled. I shall be glad to know of any cheaper and better method.

I have the honour to be, Sir,
Your most obedient servant,
PERCY A. HERFT.

As the question of locusts is being brought up in Ceylon the following note by the Assistant Government Entomologist will prove of interest and may be inserted here :—

The species of locust is not mentioned and specimens are desirable for identification. In Ceylon, the only locust that has proved a serious pest is the painted (or spotted) locust, *Aularches miliaris*, L, which occasionally appears in considerable numbers in places and does a good deal of damage to coconut and areca palms, dadaps, breadfruit trees and other plants. This insect is, however, of a sluggish nature and does not form masses and migrate from place to place, leaving a track of desolation behind it, as do the true migratory locusts of parts of Africa, India, etc. Nevertheless, it must be regarded as potentially a dangerous insect and no outbreak of it, however slight, should be neglected. It commonly occurs amongst the pernicious "illuk" grass.

In addition to the spotted locust, which is a very gaudily coloured creature, we have several species which are more closely allied to the ones which cause such havoc in the countries mentioned above. So far, these have not made themselves troublesomely conspicuous in Ceylon and they are not likely to become serious pests here at present owing to the nature of the cultivated parts of the country. Hilly and well-wooded country does not lend itself to locust invasions, but when the flat low-country is brought under cultivation it is not unlikely that Ceylon may have its share of locust-plagues. It is well, therefore, to be watchful.

The two most vulnerable points in the life-history of all locusts are (1) the egg-stage, (2) the nymphal, or "hopper" stage when the insects are unable to fly and can only hop along the ground. In the first stage, the eggs, which are laid in masses just below the surface of the soil, can be turned up by ploughing or hoeing and destroyed. In most countries which are afflicted with locust-plagues, however, it is found that the easiest and most effective way of dealing with them is to attack them while the insects are still in the young "hopper" stage. During this period, which lasts for some time, the young locusts are rounded up and either herded into deep ditches which have previously been prepared for them, or caught by ingenious nets which are dragged over the infested fields and scoop up all locusts in their path. Such methods as these only lend themselves to fairly flat country and are largely dependent for their success on the nature of the cultivated crops in the affected district.

In dealing with all locust plagues, it is necessary to watch the outbreak from the very first so as to discover the time when the insects can be most easily dealt with. In most cases, as mentioned above, this will be while they are in the "hopper" stage. Circumstances, however, vary so widely that no single method can be regularly adopted and each outbreak must be combated by such means as prove to be most effective and feasible in each case.

G. M. HENRY.

CACAO.

SALE OF COCOA.

The following prices have been obtained for cocoa in Colombo on 27th April:—

No. 1 good bright colour sun-dried	...	Rs. 52/– per cwt.
No. 2 clayed black cocoa ...	...	,, 42/– ,, ,,
No. 3 Nicaragua cocoa ...	...	,, 45/– ,, ,,
No. 4 good dull room-dried cocoa	...	,, 43/– ,, ,,
No. 5 black inferior cocoa ...	...	,, 16/– ,, ,,

It will be seen there is a difference of Rs. 9/– per cwt. between equally good cocoa but of bright and dull exterior skins which of course in no way affects the quality or flavour of the bean.

Under ordinary circumstances the difference between good cocoa and black, i.e., that obtained from unripe or fungus pods is about Rs. 20. In this case the black cocoa was roughly picked over and the unbroken beans coloured with Indian clay. These fetched Rs. 42/– per cwt. or only Rs. 10/- less than the best quality. As it costs only 60 cents per cwt. to clay the beans there is a clear profit of Rs. 9/50 per cwt. over unclayed black.

No. 5 inferior cocoa was the remainder of the broken black cocoa.

The Nicaragua cocoa fetched Rs. 8/– less than good mixed Forastero cocoa owing to its dull colour, though the beans are twice the size.

D. S. CORLETT,
Manager, Expt. Stn., Peradeniya.

MANURIAL EXPERIMENTS ON CACAO IN TRINIDAD.

J. VERTEUIL.

This report deals with the further results of the cacao experiments including manurial, shade, chupon (suckers) and natural yield plots. The manures were applied broadcast to an area within 3 feet of the trunk of each tree and the soil forked to a depth of about 6 inches. The climatic conditions were very favourable, the increase in crop over that of the previous year being in several cases as great in the no-manure (or control) plots as in those under manurial treatment.

All manures except lime alone gave an increase on the previous yields, the increases being greatest with mulch and sheep manures, either alone or in combination with artificial manures. The greatest increase (72%) was obtained with mulch in combination with basic slag and sulphate of potash, followed by a plot with a similar mixture containing pen manure in place of mulch, but owing to the high cost of the mulch the most profitable crop

($ 166 per acre) was obtained with a combination of pen manure, sulphate of ammonia and sulphate of potash. The next most profitable mixture was sulphate of ammonia and sulphate of potash, with a profit of $ 148 per acre.

The shade experiments have not yet reached a conclusive stage. Removal of shade trees in 1910 resulted in a considerable decrease in yield during 1911–13; a considerable improvement occurred in 1913–14, but the yield is still below that of the year preceding the removal of the shade.

Experiments to compare the effects of partial and complete removal of chupons appear to favour their complete removal in the case of young trees up to 10 years, but the results with older trees of 25 to 30 years do not show any definite advantage from any treatment regarding chupons.

The natural yield plots with trees 32 years old do not show any uniform variation in yield due to season and increasing age. These results give further support to the statement made in previous reports, viz., that to be able to arrive at reliable conclusions as to the relative value of different manures applied to cacao trees, it is necessary to ascertain the natural yield of the plots over a series of years previous to the application of the manures.

The general conclusions drawn from these experiments are as follows:—

(1) Although a favourable season considerably reduces the percentage of trees bearing less than a pound of dry cacao per annum, the proportion of these during the two years for the above fields is not less than 30 per cent. on an average.

(2) The comparative yield of the plots on each field for each year is largely dependent on the relative proportions of high and low bearing trees, and generally the percentage of trees bearing less than 13 pods per tree appears to exert the largest influence on the relative yield of the plots.

(3) Generally the heavy bearing trees of the first year have continued to be heavy bearers, and the poor yielding trees have remained poor during the following year; the detection of poor bearing trees on an estate and their subsequent replacement with trees raised from stock or budded trees of known prolific and other qualities is deserving of serious consideration. The advisability of improving the crop of poor yielding fields on an estate by replacing the trees which bear an average of less than 13 pods annually is clearly indicated and should form part of future experiments on the natural yield plots.—BULL. INT. INST. OF AGRIC.

To the EDITOR, TROPICAL AGRICULTURIST.

DEAR SIR,

MR. J. P. LEWIS will be glad to hear that the cultivation of the lima bean in which he is interested has been taken up extensively in the Kandyan country and that the produce is seen in the market in large quantity.

The Agricultural Society is endeavouring to eliminate as far as possible the varieties with coloured seeds as being less wholesome, and has recently imported and distributed white seed varieties.

The Soya bean is, however, not being taken up in the same way.

Yours faithfully,
C. D.

TOBACCO.

ANNUAL REPORT OF THE GOVERNMENT TOBACCO PLANTER FOR 1915.

In addition to the immediate supervision of the work at the Tobacco Trial Grounds, Jaffna, during the past year, the Tobacco Planter has visited Batticaloa, Trincomalee, Teldeniya, Rangala, Peradeniya, Galle, Anuradhapura, and practically all localities of the Jaffna Peninsula, including some of the adjacent islands. The total number of miles travelled during the year was approximately 4,500. Tobacco talks were made at most of the above-mentioned places, lands inspected, and advice given regarding the suitability of the soil for tobacco growing, and at many places growers were induced to put in trial plots, employing improved methods. Seeds have been furnished to them with written instructions regarding the cultivation, etc. A number of papers, treating of preparation of tobacco nurseries, selection and preparation of tobacco lands, and methods of cultivation, have been written for the Jaffna Local Tobacco Committee.

The total number of inward and outward letters for the year was 525.

Twelve samples of tobacco have been received for opinion, and samples from the Jaffna trial ground have been despatched to the Imperial Institute, London, for report.

A record was kept for the months of May and June during the curing, stripping and grading season, and the number of visitors was 1,800.

GENERAL METHODS EMPLOYED IN CULTIVATION.

The work as outlined in last year's report was carried through. The following methods of watering the plants were employed; the young plants were watered once every four or five days and mulched. When the watering by channels was begun, the crop was watered but once a week. As we had only one well sweep for watering four or more acres of tobacco—and a sweep is only supposed to have a capacity for watering one acre—the water was necessarily continued far up into the heat of the day, which, of course, was not the best for the crop. It was only by frequent shallow cultivation, and our system of mulching the channels, that we were able to retain anything like sufficient moisture.

The chewing types were topped and suckered in the usual manner and produced a fairly fleshy leaf of good flavour. The flowering heads were not removed from the cigar types, until just prior to harvesting, the object being to prevent the leaf from becoming too thick and fleshy for cigar purposes. Though a delay in the completion of our curing barn prevented the harvesting of our cigar types at just the proper time, the quality is quite satisfactory and the yield fair.

INSECT PESTS.

The worst insect with which we in the Jaffna Peninsula have to contend is the small black flea grasshopper, which come in large numbers to attack the seedlings in the nursery when they first appear. They bite off the tops

of the minute seedlings, and, owing to the small amount of plant food stored in the seed and the undeveloped state of the roots, at this stage, they are incapable of further growth.

Some of the most delicate types of cigar tobacco are attacked in later stages, after transplanting to the field, by the "green fly;" the larvæ of which attack the plant in great numbers. They suck the juice from the leaves, leaving them papery and lifeless.

HARVESTING.

The harvesting was done in March and April. All types except cigar wrapper were harvested by the method of splitting the stalk to within a few inches of the ground, cutting it off and placing it across a tobacco lath. Six plants were placed on each lath and the laths were hung on poles in the curing shed.

The cigar wrapper leaf was harvested by the pruning or single leaf method, as it is most important to take the leaves just at the proper stage of ripeness, and all the leaves of a plant do not ripen at once.

CURING.

Most of the crop was cured by what is known as the air curing method, with excellent results. One small amount of chewing tobacco was cured by the process known as open fire curing, and the result was good. A small quantity of the chewing type was partially cured by the flue method, but owing to the moisture in the newly-constructed walls of the flue house, built of lime, mortar and stone, we were unable to procure a sufficiently high temperature in the initial stages of the curing; so the tobacco was removed from the flue house and the curing finished in the air curing shed.

FERMENTING.

The crop was stripped and graded and the cigar tobaccos bulked for fermenting on the 8th June. As we had no regular fermenting house, the work was done in an ordinary room. The heat produced by the fermentation dried the bulk and it was rebuilt from time to time, each layer of the tobacco being lightly sprinkled with water. The process of fermentation is about completed.

FERTILIZER EXPERIMENTS.

These tests show that a manure composed mainly of nitrogen and potash is best suited for this locality. Buried tulip leaves gave the heaviest yield but not the best quality. It is interesting to note that a half portion of commercial manure and a half portion of cattle manure gave exactly the same yield as a full portion of cattle manure, the quality, in the first instance, being better. These experiments are to be duplicated in 1916.

VARIETY TESTS.

Forty-two varieties of tobacco were tried, from which twelve selected varieties were grown in the test plots. The variety tests were valuable in ascertaining what types were best suited for the Jaffna District as regards quality, and selected types from the varieties grown will be planted for the 1916 crop.

GREEN MANURE CROP.

In November the entire garden was sown to Sunn Hemp, and in December we began ploughing it under on all land intended for cultivation during the next season. The hemp, having made a good growth, provided an excellent green manure.

NURSERIES.

Our nurseries for the next crop at the Jaffna trial grounds were sown the first day of November and transplanting was begun on December 30th. On November 11th a nursery was sown at the Dry Zone Experiment Station, Anuradhapura, to provide plants for the trial plots to be located there.

PUMPING PLANT.

A pumping plant has recently been installed and will afford excellent facilities for watering the garden in the future.

BUILDINGS.

A small fire curing house and a large barn for air curing were erected.

ADVERTISING THE WORK LOCALLY.

In June, a committee known as the Jaffna Local Tobacco Committee was organised and was composed of the Government Agent, Northern Province, the Tobacco Planter, and ten leading Tamil gentlemen selected by MR. HORSBURGH. The object of the organization is to take measures to bring the work done by the Tobacco Planter and the results obtained, as well as the improved methods of cultivation and curing, to the notice of the tobacco growers, and to induce them to adopt these methods. Monthly meetings have been held, at which papers were read and approved for publication in Tamil, and distribution. Thanks are due to MR. HORSBURGH and the Committee for their interest and their efforts in the furtherance of the work.

B. F. SCHERFFIUS,
Tobacco Planter.

STIMULATING THE MILK FLOW.

The dairy cow can often be brought up to a high degree of efficiency by some very simple means. The persistency of the milker will pay well for all the extra time spent. Try to make the cow think she has not given enough and she will set about to make it up next time. A little milk left in the udder will make her think she is giving more than she is expected to, and at the next milking she will not have quite so much for you.

There is a great difference in the per cent. of butter-fat in the first and the last milk drawn. The first will sometimes be as low as 1 per cent. and the last has been known to run as high as 12 per cent. It pays to work for the strippings. The manipulation of the udder will often result in the increase of a pound of milk. This is usually done after the milker has secured all the milk he can by taking the teat in the hand and pushing the udder up close against the body, repeating this about three times with each quarter, in turn, between the hands with the hands close to the body and rub down. The extra milk secured at a single milking may not pay for the time, but it will stimulate the cow to give that much more at the next milking with extra work. Here is where the profit will come in.

We all know that a cow with which the calf is allowed to run will very soon adjust the flow of milk to the needs of the calf, and it is equally true that the dairy cow can and will increase the milk flow if encouraged by the milker. Get all the strippings. It will pay.—THE AGRICULTURAL NEWS (DURBAN).

CASSAVA.

CASSAVA: ITS CULTIVATION AND UTILISATION.

(*Continued from p. 316.*)

HARVESTING AND YIELDS.

The time of harvesting depends on the habit of the variety, on the climatic conditions, and on the use to which the roots are to be put. If required for the preparation of starch or tapioca the roots must be harvested when they contain the maximum amount of starch. Some varieties mature in as little as seven or nine months, others take twelve or fifteen months or even longer to attain their full growth, and consequently no hard and fast rule can be laid down. It has been shown, however, that no advantage is derived by allowing the roots to remain in the ground after they have become mature; they may continue to increase in size, but they become more fibrous and woody and so are less suitable for the manufacture of starch. As the roots do not keep well after being removed from the soil, except with very careful treatment, they are only dug as required when used for food. If frosts are likely to occur, an early maturing variety must be chosen, so that the roots can be dug before the cold weather sets in.

Owing to the size of the roots they have to be removed by hand. In very light soils this can be done without the use of tools by simply grasping the base of the stem with the hands and pulling the roots. Much labour and time can be saved, however, by the use of some simple tool, which is always necessary on heavier soils. Sometimes an ordinary grubbing hoe is used, but perhaps the most convenient tool consists of a V-shaped hook 5 or 6 inches in length, one arm of which is fixed to a wooden pole, 8 feet in length and 2 inches in diameter, at a distance of about 2 feet from the end. To lift the roots the hook is placed under the point of attachment of the roots to the stem and the whole cluster then levered up. To prevent the end of the lifter sinking in the soil, a flat piece of iron or an old spade is sometimes fixed to the short end, and this is also useful for any actual digging which may be necessary. The work is much facilitated if one or two men precede the diggers and cut down the stems to within 6 inches of the soil.

The yield of roots varies considerably in different countries, and depends not only on the variety grown but also on the character of the soil, the amount of cultivation which has been given, and the vigour of the original cuttings. On poor soils the yield may not exceed 2 or 2½ tons of fresh roots per acre, but on a particularly good soil as much as 15 tons per acre has been obtained in the United States. Much higher yields than this have been reported, but as a rule these are estimates obtained from the weight of a few roots and cannot be accepted as representative of actual practice. On the whole, 8 tons of fresh roots may be considered a good average yield.

No attempt will be made to recommend any particular varieties for cultivation, as the yield of one and the same variety varies in different localities and on different soils, and it is necessary to carry out careful tests of a

series of varieties before the best for any given place and purpose can be correctly ascertained. As a rule the bitter varieties give a higher yield of roots than the sweet varieties, and are therefore preferred for the production of starch, but under the conditions obtaining in the United States sweet cassava has given the best results for this purpose. Not only does the yield of tubers vary in the different varieties, but also the starch content and the time of maturity, as is shown in the following table, which gives the results obtained in a series of experiments carried out a few years ago at the Hope Experiment Station, Jamaica :—

Variety.	Yield of roots (tons per acre).			Quantity of starch in the roots (lb. per acre).		
	At 12 months	At 15 months	At 21 months	At 12 months	At 15 months	At 21 months
Blue Top ...	8·25	14·2	21·9	5,636	9,733	15,818
Black Stick ...	6·5	6·5	18·0	4,878	5,197	15,433
Smalling ...	7·5	11·1	19·3	5,494	8,553	13,883
Mullings ...	5·75	11·1	18·0	4,160	8,180	13,277
Long Leaf Blue Bud	9·0	15·4	15·4	6,552	12,857	13,187
White Top ...	10·5	11·0	11·6	7,902	7,638	8,753
Luana Sweet ...	6·75	8·1	9·0	5,322	6,540	7,102
Rodney ...	7·5	9·7	10·3	5,337	6,931	6,547

HYDROCYANIC ACID IN CASSAVA.

The presence of hydrocyanic acid (prussic acid) in cassava roots was first recorded by BOURBON-CHARLARD in 1836. As a result of investigations conducted at the Imperial Institute it was ascertained that the acid does not wholly occur as such in the root, but is generated by the action of an enzyme on a glucoside. The latter was subsequently ascertained to be phaseolunatin, which also occurs in certain varieties of *Phaseolus Lunatus* beans (DUNSTAN, HENRY & AULD, Proc. Roy. Soc., 1906, B, 78, 152). Owing to the great importance of the subject most of the investigations on the occurrence of hydrocyanic acid in cassava have been concerned with determining the amount yielded by sweet and bitter varieties respectively. FRANCIS in 1870 was the first to show that hydrocyanic acid is yielded by sweet cassava roots. He found that the average amount furnished by the whole root was 0·0168 per cent., the highest being 0·0238 and the lowest 0·0113 per cent. CARMODY, in a paper published in the LANCET in 1900, showed that although sweet cassava may yield as much hydrocyanic acid as the bitter form, there is a difference in the distribution of the acid in the roots in the two cases. In the sweet variety he found that most of the hydrocyanic acid was in the skin and outer cortical layer, whilst in bitter cassava it was more evenly distributed through the root. As it is the almost universal practice to peel the sweet cassava roots before eating them, the fact just mentioned explains why cases of poisoning by this variety are so rare. Typical examples of CARMODY'S

results are shown below :—

Sweet Cassava.		Bitter Cassava.	
Inner part.	Skin and outer cortical layer.	Inner part.	Skin and outer cortical layer.
Per cent.	*Per cent.*	*Per cent.*	*Per cent.*
0·006	0·033	0·031	0·024
0·003	0·014	0·021	0·025
0·015	0·033	0·014	0·013
0·008	0·031	0·017	0·019
0·011	0·020	0·016	0·024
0·004	0·024	0·013	0·016
0·010	0·030	0·032	0·035

These results have been confirmed in the main by subsequent observers. COUSINS, for example (BULL. AGRIC. DEPT., JAMAICA, 1907, 5, 78), found that twenty-four out of twenty-six Columbian varieties of sweet cassava grown in Jamaica had most of the hydrocyanic acid in the cortical part of the root. The remaining two, although sweet to the taste and found by actual experiment on four persons to be non-poisonous, contained 0·0062 and 0·0024 per cent. of hydrocyanic acid in the cortex and 0·0114 and 0·0130 per cent. in the interior, respectively.

MOORE (BULLETIN No. 106, 1906, BUR. CHEM., U. S. DEPT. AGRIC.), however, found that in specimens of both bitter and sweet cassava grown in Florida, most of the hydrocyanic acid was in the skin and cortex. His results were as follows :—

	Sweet cassava (Florida Sweet.)		Bitter cassava (White Top).	
	Proportion of part to whole root.	Hydrocyanic acid.	Proportion of part to whole root.	Hydrocyanic acid.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*
Skin ...	1	0·068	1	0·076
Cortex ...	25	0·054	12·5	0·023
Inner part ...	74	0·002	86·5	0·0005

MOORE states that the proportion of hydrocyanic acid present varies not only with the variety but also with the size of the root. The smaller roots, containing a relatively larger proportion of skin and cortex, yield more acid than larger ones, whilst the lower part of a tapering root of a bitter variety (White Top) contained 0·039 per cent. of hydrocyanic acid, the large upper

part containing 0·028 per cent., whilst a small root of a sweet variety (Florida Sweet) contained 0·005 per cent., the average-sized root of that variety containing only 0·002 per cent.

COLLENS (BULLETIN, DEPT. AGRIC. TRINIDAD AND TOBAGO, 1915,14,54) obtained somewhat similar results in the case of bitter cassava, but in roots of sweet cassava he found that the lower part yielded less acid than the upper. So far the reason for this difference has not been ascertained.

The amount of hydrocyanic acid in cassava may also be increased or diminished when a variety is grown in a new locality. COUSINS (BULLETIN AGRIC. DEPT., JAMAICA, 1907,5,78) found that a number of Colombian varieties of sweet cassava when grown for one year in Jamaica yielded on the average 0·0034 per cent. of acid, but after having been grown for five years the yield was 0·0124 per cent.; the increase in this case was mainly in the cortex, which yielded an average of 0·0649 per cent. of acid. The results obtained by MOORE in Florida, on the other hand, seemed to indicate that the yield of acid decreased after continued cultivation.

The fact that the yield of acid varies when one and the same variety is grown in different localities, was also demonstrated by MOORE, who obtained the following results among others:

Variety.	Miami, Florida. *Per cent.*	Biloxi, Missouri. *Per cent.*	Cuba. *Per cent.*
1. Helada	0·010	0·003	0·015
2. ,,	0·001	0·001	0·016
3. Negrita	0·005	0·007	0·007
4. ,,	0·002	0·003	0·022
5. Pie de Perdiz	0·009	0·001	0·008
6. Mantera	0·008	0·002	0·040

Hydrocyanic acid is yielded by all parts of the cassava plant, as is shown by the following results given by COLLENS in the paper referred to:

	Sweet *Per cent.*	Bitter. *Per cent.*
Top: Full-grown green leaves	0·0162	0·041
Green stem where leaves arise ...	0·0144	0·024
Woody mature stem: Green cortex or peel ...	0·043	0·113
Inner woody portion	0·0072	0·0027
Pith	0·019	0·076
Roots, freshly dug: Peel	0·0147	0·055
Inner part	0·0048	0·053

—IMP. INST. BULL.

According to the WEST INDIA COMMITTEE CIRCULAR a cacao tree on an estate in the Tamana Ward in Trinidad has set botanists talking by producing two distinct kinds of cacao pod on the same branch, a red pod of the *forastero* variety and a yellow one of the *calabacillo*. At a recent picking the tree yielded eleven yellow pods and seven red ones.

SOILS AND MANURES.

THE RESPECTIVE VALUES OF ORGANIC AND INORGANIC MANURES.

H. E. P. HODSOLL.

(Continued from p. 325.)

Biological.—Lastly, let us consider the effect of these two classes of manure on the bacterial life of the soil. This is, perhaps, the most important aspect of all. For some time it had been difficult fully to explain the effect of organic manures on the growth of the crop, and to account for this fact that plants so fed seemed to have more "life" in them. One could only say that decayed animal and vegetable matter was the natural plant food, and that there was probably some affinity in the life of the organic materials—as evinced by the growth of fungi, etc., that they support (by some erroneously considered a disadvantage)—and the life of the plant; though, needless to say, this was scoffed at by the holders of the mineral theory.

Recent work on bacteriology undertaken and ably carried out, among others, by RUSSELL and HUTCHINSON of Rothamsted, has thrown much light on the subject. They have shown that bacteria are absolutely dependent upon humus in the soil, that they feed on it, use it as their fuel, and get their energy and power from its combustion, and it is thus absolutely essential for their life.

We now know that the soil is not an inert mass acting merely as a medium to hold plant foods, and an anchorage for their roots, but that it is indeed a life, that it is in fact a huge factory peopled by millions of minute organisms that are there to prepare the food already in the soil and supplied as manure for the delicate root hairs of the plant.

It has been shown that these workers are wonderfully organised; that there is a perfect division of labour among them, each group having its appointed task; when each particular group has done its part, it, so to speak, hands it on to another for the next operation, and so on until the insoluble material on which they are working has been completely broken down into a form readily assimilable by the plant.

When we realize that such substances as farmyard manure would not only be useless but actually harmful to the plant were it not for the action of these beneficial bacteria, we begin to see the importance of the part they play in plant nutrition and in the great scheme of life.

It is impossible in the short time we have at our disposal to go into this fascinating study, but as an instance of how these minute organisms work it is interesting to note that every organic manure that is applied to the soil has to be attacked by at least three separate groups of bacteria before the plant can get at the ammonia it contains, the nitrogen being first turned to ammonia, then to nitrite and then to nitrate, which is soluble and can be taken up by the plant.

Another bacterium has the power of fixing the free nitrogen of the air and bringing it into use for the plants.

Bacteria also play an important part in bringing phosphates and potash into solution. It has been proved that mineral phosphates only work well on a soil containing plenty of organic matter; this is because the carbonic acid gas generated by the bacteria enters into the water and dissolves the phosphates, otherwise they are very ineffective.

It is clear, therefore, that we are absolutely dependent on the bacteria in the soil, and especially is this the case with the intensive cultivator who uses the soil as a manufacturing medium to convert the fertilizers he applies into crops.

As I have said, bacteria feed on humus and must have it, and we therefore see how necessary it is to use organic manures that supply this all-important ingredient.

On the other hand, the mineral manures, as we have seen, not only contain no humus, but by the acid residues they leave in the soil (especially superphosphate and sulphate of ammonia) and by the bad effect they have on its physical condition, they are actually harmful to bacterial life.

So that from this aspect also we see that the organic manures are far preferable to those obtained from mineral sources.

In spite of these great advantages, however, I do not deny that the minerals have their uses. For rapid results, in cases where we want to stimulate the plant into very quick growth, we must use the mineral forms of nitrogen—such as nitrate of soda, nitrate of lime, sulphate of ammonia, etc.—because they require to undergo practically no change before being taken up by the plant. They produce an unnaturally quick, soft, and sappy growth, just the thing we want to avoid in permanent crops like fruit, but, on the other hand, just the thing we require in green crops like cabbage, lettuce, etc., because besides giving us earliness they also produce a tender leaf, though, if this is over-done, the produce is apt to be unwholesome as food.

There is probably also another reason why minerals are of considerable value, and this is the subject of very interesting investigation by the American agricultural chemists.

It is now generally admitted that all plants as a result of their growth give rise to a certain toxin or poison in the soil, the toxin being peculiar to the particular crop, and, as a rule, a poison only to that crop. In some kinds of plants this is much more noticeable than in others; probably two good instances are strawberry and clover, which, as we know are difficult to grow continuously on the same site. At the other extremity we have wheat and mangolds, which Rothamsted shows us can be grown for many years in succession on the same soil.

These toxins have probably a great deal to do with the advantages of rotation, as this system gives the soil time to rid itself of these substances, which we must remember are poisonous to the one crop only.

Intimately connected with this matter is the recent work of RUSSELL and HUTCHINSON on soil sterilization. They found that after the soil had been sterilized plants grew very vigorously in it. The reason for this vigorous growth is probably that owing to intensive cultivation the bacterial flora had got out of balance, and that a certain comparatively big amœba that feeds on the beneficial bacteria had got the upper hand.

Owing to its larger size this amœba is more vulnerable, and suffers more than the beneficial bacteria from the sterilization; consequently, after that operation, the latter, being relieved to a large extent of the preying of the amœba, are able again to flourish, with the result that they carry on work more vigorously than ever, and large quantities of dormant food material are again prepared for the plant.

The reason why I have mentioned this is that the work of the Americans goes to show that the mineral manures act on the soil as a partial sterilization: that is, to bring about to a slight extent the state of things to which I have just referred; and for this reason they are beginning to regard them as useful, mainly for combating the soil toxins.

This is a most interesting theory, and if correct—as there seems every reason to believe—provides a further instance of the use of minerals.

The practical conclusion of the matter is therefore probably this:—

Use organic manures as a base to supply humus, and thus improve the texture of your soil and enable you to get a good tilth and a good seed bed, to give you gradual feeding of the crop, which promotes healthy growth and good quality, and to provide humus to feed bacteria.

Use mineral manures as a top dressing for rapid growth, and to act as a sterilizer to keep the bacterial flora in balance.—JOUR. OF THE ROYAL HORTICULTURAL SOCIETY.

EFFECT OF REMOVING SOLUBLE HUMUS FROM SOIL.

WILLIAM WEIR.

The only experiment on the part played by soluble humus in plant nutrition was recorded by GRANDEAU in 1872. Removal of the humus by means of hydrochloric acid and ammonia rendered the soil sterile to the growth of beans.

During the past two years this experiment has been repeated on a larger scale. The removal of the soluble humus was effected by washing the soil with dilute hydrochloric acid to remove bases and then repeatedly extracting with dilute soda. Some 40 per cent. of the nitrogen in the soils was removed in this way.

Two soils were used: a medium garden soil and a typical loam. Two pots of each soil were used: one treated and the other untreated. Chalk was added to the treated soil to replace the carbonates removed by the acid treatment and 1 gram KH_2PO_4 in solution was added to each plot. Wheat was sown in March, 1914, and cut in August. The soil was then taken out, mixed afresh and replaced ready for sowing with mustard. This crop, which scarcely grew beyond the seed-leaf stage, was removed on October 8th and weighed. The soils were then cultivated but not otherwise disturbed, and on October 13th all the plots were sown with rye and grown in the glasshouse until February 18th. Mustard was then sown as the fourth crop after removing and drying the soil.

The crop and nitrogen data for the different soils are summarised in the following table:—

Soil.	Wheat.		Mustard.		Rye.		Mustard.		Total weight.	
	wt. of crop.	wt. of N.	wt. of crop.	wt. of N.	wt. of crop.	wt. of N.	wt. of crop.	wt. of N.	wt. of crop.	% of N.
Medium garden soil	67·8	·64	2·7	·06	3·1	·12	11·3	·24	84·9	1·07
,, ,, extracted	72·3	·73	3·9	·08	3·7	·14	10·8	·24	90·7	1·19
Typical loam	45·3	·37	13·1	·025	5·4	·20	15·4	·30	79·2	1·13
,, ,, extracted	67·2	·71	0·9	·03	6·6	·28	1·3	0·5	76·0	1·07

Thus, in five cases out of eight the plants obtained more nitrogen from the extracted than from the untreated soils; in one case the amount was the same and in two cases the amount was less, but on both these occasions the crop (mustard) failed on one soil.

During 1914-15 additional quantities of the same two soils were extracted and sown with wheat in precisely the same manner. In this case a smaller amount of humus (36 per cent.) was removed. In the case of the garden soil sown with wheat in November the untreated soil gave a better crop, whilst in the loam soil, which was not sown until March, the plants in the extracted were greener and weighed heavier than those in the untreated soil.

Determination of the nitrate and ammonia production and bacterial counts were made of the four soils. The formation of nitrate was less marked in the treated soils, in which ammonia tends to accumulate. The untreated soils appeared quite normal in this respect. The numbers of bacteria in the treated soil are initially very low, then become abnormally high and remain above the usual level; there is, however, no corresponding increase in the production of ammonia and nitrate. This result is similar to that obtained by BUDDIN on treating soils with non-volatile antiseptics.—BULL. INT. INST. OF AGRIC.

SOME SOIL PROBLEMS.

E. J. RUSSELL.

We have seen that most of the changes can be brought about by a number of organisms. Thus the fixation of nitrogen may be effected by the ærobic Azotobacter or the anærobic Clostridium. The production of ammonia can be brought about by moulds, by large bacilli, or by small micrococci, organisms differing considerably in their requirements. Thus the continuance of the decomposition is less dependent on the conditions than might *a priori* be expected, and if the reaction cannot be brought about by one set of organisms it can by another. Changes in conditions may alter the speed of the reaction or they may alter the agents bringing it about, but they have less effect on the nature of the change.

For example: the bacterial flora in acid soils devoid of calcium carbonate is very different from that in normal soils, but one cannot point to any reaction that is wholly suppressed in consequence. It was once thought that nitrification ceased, but later work shows that this reaction, sensitive as it is, still goes on, although at a greatly reduced speed.

It has not yet been found possible to connect the change with the agent —to say at a given moment which organisms are playing the most important part at that time.

The obvious method of studying the changes in the soil is to observe the growth of plants, but the phenomena involved are too complex to be readily interpreted.

For our present purpose we can follow the changes in the soil by three methods:—

(1) Measuring the rate at which oxygen is observed or carbon dioxide is given off by the soil.

(2) Measuring the rate at which ammonia or nitrate is formed in the soil

(3) Estimating the changes in numbers of bacteria in the soil.

The first two can be determined as accurately as is desired, but the accurate estimation of bacterial numbers is not yet possible and the values are comparative only; nevertheless they are of considerable value for our work.

First of all we may take it as a general rule that the soil organisms, being living creatures, are dependent on suitable temperature and water supply, that they must have food, and also sources of energy to enable them not only to live but also carry on those reactions which involve the accumulation of energy, or, in other words, resemble the rolling of a ball up a hill. These are general requirements that can safely be predicted of any living organism. In addition there is the special requirement that has been discovered by experiment: the need for calcium carbonate, without which many soil organisms will not act efficiently.

The application of general rules to soil problems is a very treacherous business; it is commonly the unexpected that happens, and experimental confirmation is therefore required at every stage. In order to get at the general nature of the effect of temperature and moisture content on the decomposition process it is necessary to do experiments in the laboratory, where all the conditions can be carefully controlled. Experiments show that the effect of rising temperature on the bacterial numbers is quite different from what one expects: instead of rising, the numbers remain fairly constant up to about 80°F., and then they begin to fall.

In like manner, increases in water content of the soil do not lead to regular increases in bacterial numbers; there is a rise at first, but it is not sustained. So in natural conditions the numbers of bacteria do not show the expected fluctuations in the rise in temperature or moisture content. The discrepancy has been traced to the circumstance that the soil population is complex and is not formed of bacteria only. The figures do not give the effect of temperature or moisture supply on the whole soil population, but only on part of it, and they indicate a competition or a destructive effect. When the soil population is simplified by killing the less resistant forms one obtains much more consistent results. Thus soil which has been treated with mild poisons such as toluene shows the expected increase in bacterial numbers with rise in temperature or moisture.

These facts, and others which need not now be dealt with, indicate that the soil bacteria are subject to the operation of some limiting factor quite distinct from temperature, moisture content, or food supply, and I have in other papers argued that this limiting factor is to be found in the action of some of the less resistant and larger forms, such as the protozoa, which keep down

the numbers of the bacteria. This hypothesis explains all the facts that have yet been ascertained, but so many kinds of protozoa have now been discovered in the soil that it is difficult to pick out the exact offenders and render the hypothesis more precise from the purely zoological standpoint. We shall find, however, that the simplest way of interpreting the phenomena is to recognize the complex nature of the soil population and to admit it in the case of any other population. We shall run into great difficulties if we make the common mistake of supposing that all soil organisms are there for the express benefit of our plants and our crops.

The amount of nitrate production does increase with the temperature, and in this respect it differs from the numbers of bacteria. This is in accordance with expectation; up to a certain point an organism may be expected to do more work as the temperature rises, but the increase is not as great as one would get if the numbers increased as well.

When we now turn to the field conditions and try to follow the production of nitrate in the soil, matters are complicated by the fact that the nitrates produced do not all remain in the soil, but are liable to be washed out or taken up by plants. Analytical determinations, therefore, only give difference between the amount formed and the amount lost; they do not show how much is actually produced, nor give the rate of production that we desire to obtain. For some time we could see no way of getting over the difficulty, but a simple solution was ultimately found. It is evident that if the curves showing the amount of some other substances produced in the same way as the nitrate, but lost in a different way, are of the same general shape as the nitrate curves, then the shape is due mainly to the production factors: if, on the other hand, the two sets of curves are different in shape, then the loss factors control the situation. The carbon dioxide in the soil air satisfies these requirements; it is produced, like nitrates, by bacterial action, but it is lost largely by gaseous diffusion, and only in very wet weather by leaching. Carbon dioxide was therefore determined simultaneously with nitrates, and the curves show a marked similarity except that the increases in nitrate came later. Thus we may conclude that the curves both for nitrate and carbon dioxide are in the main production curves.

The amount of carbon dioxide in the soil air, which, as we have just seen, indicates the rate at which it is produced, follows the soil temperature during the winter months, but not during the summer; indeed, during hot weather the amount is distinctly low. It does not show any very close connexion with the moisture content, but it is more closely related to the rainfall.

Thus it appears that rain does something more than add water to the soil, and an interesting problem is re-opened which has in the past occupied a great amount of attention from agricultural chemists. From time immemorial practical men have felt that rain had a fertilizing effect. Medieval writers attributed it to some ærial spirit or celestial nitre washed down. LIEBIG, more precise, put it down to ammonia. As a result of LIEBIG's support a vast number of analyses have been made of rain from all parts of the world, but all agree in showing that there is not enough ammonia present to make any practical difference.

To what, then, are we to attribute this marked effect of rain? In soil investigations the direct attack is often least effective: it is usually necessary

to work round the problem and see it from another point of view. In this case help came from a rather unexpected quarter. During the course of other soil investigations it was found that soil particles possess two atmospheres: the free atmosphere in the soil pore spaces, and another atmosphere dissolved in the soil water or soil colloids.

Table showing Composition and Volume of Soil Air and Atmosphere.

Soil Air.			
	Per cent.		
	CO_2	O_2	N_2
Free air	0·4	20·3	79·3
Dissolved air	98·0	—	2·0
The Atmosphere.			
	0·03	20·97	79·0

The free atmosphere is very much like our own, except that it contains more carbon dioxide; it is eminently suitable for ærobic organisms. The dissolved atmosphere, however, is entirely different: it has not been fully investigated, but it is known to be almost devoid of oxygen and to consist mainly of carbon dioxide and nitrogen. The fact that it exists in such close proximity to the free atmosphere shows that the oxygen is used up more rapidly than it is renewed, and this means that the plant roots and micro-organisms which are immersed in the soil water are perpetually in need of more oxygen. So far as we know there is no process in the soil that will hurry up this renewal of dissolved oxygen, and plants and micro-organisms alike are perpetually restricted by the lack of it.

Now rain is a saturated solution of oxygen, and when it falls on the soil it not only supplies the needful water but also renews the stock of dissolved oxygen, and thus gives the micro-organisms and the plant roots a new lease of activity.

But the soil is not governed solely by the conditions that happen to obtain at the time being; it is profoundly influenced by those that have passed: indeed, one might go so far as to say that its properties are determined largely by its history. The shape, size, and to a large extent the composition of the mineral particles are the result of forces that caused the fragments of rock to chip off long ages ago, and have governed their wanderings ever since. The nature of the organic matter depends on the past vegetation, and this in turn on the climate; the micro-organic population is determined by vegetation, climate, and other causes. The soil as we see it to-day is the result of changes and climates long since past as well as of those now present. In short, the soil is the embodiment of its past history, and can only be studied properly in the light of its history.

This is equally true of the minor events. Changes in conditions do not cease to be effective as soon as the old conditions are restored; they leave their mark, which may persist for a long time and lead to very unexpected results. Experiments at Rothamsted and elsewhere have brought out the apparent paradox that conditions harmful to life lead to greater bacterial

activity as soon as they have passed, while conditions favourable to life finally cause decreased bacterial activity.

Thus, if a soil is dried for a time and then re-moistened, it becomes a better medium for the growth of plants and of bacteria, the production of nitrates is increased, and the supply of phosphate becomes more available. The bacterial numbers do not, however, undergo any visible change.

Productiveness of Soils stored dry. (Oats: Gedroix, 1908)

No. of years of Storage.	No. Manure.	Complete Manure.	Complete without Nitrogen.	Manure without Phosphate.
0	10·3	83·5	13·5	11
1	17·8	83·9	32·3	19
3	24·6	90·9	23·6	35·4
5	25·0	102·8	32·2	42

When soil is exposed to severe cold there is an increase in nitrate production, and, in this case, in bacterial numbers also. Exposure to heat causes a similar change. Greater growth is commonly obtained wherever a bonfire has been made, and in India it has been the practice from time immemorial to heat the surface of the land before growing the rice crop. Volatile antiseptics are now known to have a like result.

The converse of the rule is also true: whenever a soil is well supplied with organic matter, with moisture, and kept well warmed, the bacterial numbers do not remain as high as might be expected, but on the contrary they tend to come down. After a time these soils fail to produce their full effect and they are said to become "sick." Instances occur in commercial glasshouses run at high temperature where the soil after a season's use becomes unsuitable and is therefore thrown out, all its valuable manurial residues being sacrificed.

Sick soils have been examined in some detail, and the trouble was traced to at least two causes: an accumulation of disease organisms, and also an exaggerated activity of the factor limiting bacterial activity in ordinary soils.—JOUR. OF THE ROY. HORT. SOC.

DETERMINING THE NUMBER OF PROTOZOA IN SOIL.

G. P. KOCH.

The supposed noxious action of the protozoa of the soil with respect to other micro-organisms has drawn the attention of biologists to the protozoology of the soil in its relation to fertility.

The writer remarks on the inefficiency of the methods at present in use for determining the numbers of protozoa and suggests an improvement on the platinum loop method with an average experimental error of about 7 per cent.

Culture solutions were made with extracts of dried blood and soil (*Löhnis*) containing bi-potassium phosphate, inoculated with different amounts of manured greenhouse soil and incubated at 22°C for 30 days. Each day the numbers and types of protozoa were examined.

The maximum number of protozoa varied with the culture solution and the condition and amounts of soil used for inoculation. In dried blood extract the maximum development of all protozoa occurred earlier than in hay infusion, and after the maximum was reached the number of protozoa gradually diminished. Development was also early in solutions to which large quantities of soil had been added, but the number of protozoa per gram of soil was greater when only 1 gram was added instead of a larger quantity. Extract of soil is more favourable to the development of protozoa than dried blood. Dried soil favours the development of flagellates, whilst dried blood causes only a slight difference.

Flagellates are first in leaving the encysted condition and they are much more numerous than the ciliates, which vary in number in inverse proportion to the quantity of manure in the soil, whilst in the extract of dried blood the flagellates developed better with inoculations of heavily manured soil. Numerous types of ciliates are found, but few types of amœbæ.

Another series of experiments, in which extracts of blood and hay infusions were inoculated with greenhouse and field soil, gave analogous results. Hay infusion was a better medium than extract of dried blood for all forms of protozoa, probably on account of the medium being more suitable for bacteria.

To study the effects of various temperatures of incubation, different amounts of soil were inoculated into dried blood extracts and hay infusion and incubated at temperatures from 5° to 30°C for 30 days. In hay infusion the small ciliates develop sooner at the higher than at the lower temperatures. Blood extract and infusion are both unfavourable media for the development of large ciliates, which flourish at all temperatures used if conditions are favourable. Flagellates developed at a lower temperature than the ciliates, reaching a maximum of 6° to 7° in dried blood extract and 15° to 16°C in hay infusion, which is therefore the better culture medium.

In general the development of each species of protozoa depends upon the following factors: the nature of the medium, the quality and quantity of the soil inoculated, and the temperature of incubation.—BULL. INT. INST. OF AGRIC.

MANGANESE AS A FERTILISER.

Of recent years much discussion has ranged round the question whether salts of manganese are or are not capable of increasing the yield of crops. Yet, in spite of the discussion and of the very numerous experiments made to test the action of salts of manganese, no certain rule for the guidance of the practical grower has been enunciated. That this is so is due not to shortcomings on the part of the investigators, but to the fact that soils differ so much from one another, and are the seat of such complex and contradictory chemical changes, that results obtained with soils of one kind differ absolutely from those obtained when other soils are used. It is probable, indeed, that the experimenters who have been engaged in researches with manganese have been for the most part anxious to obtain results of service to agriculturists,

and that this anxiety, so much in evidence at the present time, has defeated the object which they had in view. Nature only answers simple questions, and the simple questions in the present case have not yet—so far as we know—been put to her. It is true that all plants contain manganese, but it cannot be stated with certainty that manganese is an essential constituent of plants. It is also true, as BERTRAND was the first to show, that traces of manganese play the part of activators of the oxidation processes of soils and plants; but it cannot be asserted that the acceleration of oxidation processes is necessarily an advantage to the plant. The plant, like the human tiller of the soil, has a labourer's stroke. It must grow at its own rate, and in its growth oxidation and reduction processes alternate and reciprocate. Wherefore it is probable that the curious and capricious effects of manganese will be explained only when investigators begin their investigations in a scientific spirit, and at the beginning ascertaining first by the classic methods whether a plant can do without manganese, as the textbooks' omniscience says it can, and whether the addition of manganese to nutrient solutions of known and varied compositions produces any positive effect on growth. The most recent investigations of the manganese problem, carried out by MESSRS. SKINNER AND SULLIVAN (BULL. 42, U. S. DEPT. OF AGRIC.,) raise our hopes at the outset, only to dash them at the conclusion. The investigations are as thorough as they can well be. They include experiments with pot-cultures and field-culture, but, nevertheless, the conclusions to be drawn from them are not decisive. Working with Wheats in pots of unproductive sandy loam, MESSRS. SKINNER AND SULLIVAN find that manganese salts—chloride, sulphate, nitrate and carbonate—all accelerate growth. The increase is most marked in the case of soils treated with manganese chloride, and almost as great in the soil to which manganese sulphate is added. It is moreover, considerable, and up to a certain point progressive. The addition of 10, 25, and 50 parts of manganese chloride per million of soil results in an increase of crop weight of 19, 29 and 31 per cent. A further addition of the salt reduces the effect. When, however, similar experiments were conducted with a productive loam the result of adding manganese salts was negligible—the plants grew as well in the normal as in the treated soil. Experiments made with extracts of soils similar to those used in the previous tests show that in the case of Wheat plants grown in the soil solution from the sandy loam the oxidation power of the plant is increased by the addition of manganese salts, and that in the case of Wheat grown in the extract from a productive loam it is not.

Thus it would appear that in a poor soil the addition of small quantities of manganese chloride or sulphate is likely to lead to increased growth, but that on a fertile soil to add manganese salts is waste of time and money. Unfortunately the field trial made by MESSRS. SKINNER AND SULLIVAN, though it does not necessarily invalidate this conclusion, does not lend it support. Various crops, Wheat, Rye, Corn, Cowpeas and Potatoes, were grown on a silty clay loam, low in organic matter. The physical condition of the soil was rather poor and the soil was lime-hungry. The result was that in the case of most of the crops the addition of manganese (in the form of sulphate) did not produce any beneficial effect.

The experiments are to be continued, and the acid state of the soil having been remedied by the application of lime, it may well be that the next few years will tell a different experimental tale. In the meantime the enterprising gardener may, if his soil be very poor, try the effect of giving it a very moderate dose of manganese chloride or sulphate, but if it be of good heart he had better leave it alone so far as manganese manuring is concerned.

—GARDENERS' CHRONICLE.

TROPICAL AGRICULTURE IN CEYLON.

REPORT OF THE CEYLON AGRICULTURAL SOCIETY FOR 1915-1916.

(Submitted to the Ceylon Agricultural Society at the Annual Meeting held at Colombo on June 6th, 1916.)

MEETINGS.

The last annual meeting was held on 31st August, 1915, at the Council Chamber when the HON'BLE MR. R. E. STUBBS, Colonial Secretary, presided. Since then 2 quarterly meetings were held, one at Galle Kachcheri on 30th November, 1915, at which The HON'BLE MR. R. B. HELLINGS, Government Agent, Southern Province, took the chair, and the other at Jaffna Kachcheri on 29th February, 1916, when MR. B. HORSBURGH, Government Agent, Northern Province, presided.

Both meetings were well attended and evoked much local interest, proving the wisdom of the decision arrived at on the suggestion of SIR ROBERT CHALMERS that ordinary meetings should be held in rotation at the chief provincial towns. This was specially the case at Jaffna where the gathering was particularly large, representative and enthusiastic, and a number of new members were enlisted. Much of the success of the Jaffna meeting is to be credited to MR. V. M. MUTTUKUMARU, the Maniagar of Jaffna, whose interest in the welfare of the Society and solicitude for the convenience and entertainment of the visitors to Jaffna deserve special mention.

The more important subjects discussed at these meetings were:

(1) Coconut Cultivation in the Southern Province
(2) Tobacco Growing as a Profitable Industry
(3) The Control of Water on Paddy Lands
(4) The Curing and Fermenting of Tobacco
(5) Cattle Insurance
(6) Dry Farming
(7) The Growing of Dry land Crops under Irrigation.

MEMBERSHIP.

During the period under review the following members joined the Society :— H. LEONARD COX; J. G. ABEYDEERA; NAITO; MRS. H. L. S. INGLES; ROBERT & CO., G. W. H. GORDON: A. THOMSON; SUPERINTENDENT, Pulna Burong Estate; F. T. D. P. GUEL; S. CHELLIAH; C. H. A. SAMARAKKODY; M. B. ALAWATUGODA; HARRY JAYAWARDENE; E. V. GOONERATNE; E. B. GOONETILLEKE; D. M. SENEVIRATNE; J. A. AIYADURAI; O. L. DE KRETSER; A. S. GOONEWARDENE; THE MANAGER, Sanadja Estate; ST. V. B. DOWA; JESUS MONTENEGRO: H. F. J. GARDNER; GEO. M. CRABBE; MC. DOUGALL BROS.; M. G. KEUNEMAN; M. G. SAMAREE; MANAGER, Brooklands Estate; HARRISONS AND CROSFIELD, S. I.; MRS. A. J. PEARSON; DR. CHAS. AMARASURIYA; J. S. ARMSTRONG; DR. JOHN ROCKWOOD; LIONEL P. EDWARDS; SUPERINTENDENT, Tirrukkovil Estate; H. D. GARRICK; R. DE LAVAL WALKER; C. A. GUNARATNE; N. E. WIJESEKERE; DR. MARCUS ROCKWOOD; J. A. BLAND; REV. F. L. W. WICKREMESINGHE; W. BALASURIYA; CHAS. WOOD; G. M. ALLES; C. B. BARBER; A. KOCH; L. T. AB PAN; C. P. DIAS BANDARANAIKE; MOULMEIN PHARMACY;

LE SECRETARIET SYNDICAT DES FAB SUERA; MG. THIER NYA; H. J. RODBARD; AFRICAN LAKE CORPORATION; OFFICER IN CHARGE, Agri. Station, Wiosa; OFFICER IN CHARGE, Agri. Station, Juaso; KELANTAN COPRA CO., LTD.; MRS. MARIAN A. MC ADOW; G. LAMBE; TAITO-SEITO-KAISHA; I. H. PYE; L. B. WARAKAULLE; MRS. C. M. MELLOR; F. D. SAMARASINGHE; E. RAMALINGAM; A. SAPAPATHY; REGINALD M. FERNANDO; EM. JOS. SCHRAM; P. DE P. CAREY; SECRETARY, Indian Tea Association; BEYNIS FRERES; PROSPECT GROUP OF ESTATES; A. C. W. SAMARAKOON; W. D. T. KULATILLEKE; P. RAJAGOPAL; S. KANDYAH; M. SWAMINATHAN; T. RAMASWAMY PILLAI; T. C. CHANGARAPILLAI; V. MUDALIYAR CHITTAMBALAM; J. N. SANDRASEGARA; V. CHELLIAH; DR. S CHINNAYAH; S. THAMBAYAH PILLAI; REGIS RAJAGARIAR; JOHN RODRIGO, S. TISAVANATHAR; HON'BLE DR. RUTHERFORD; DON ALBERT KEKULAWALA; D. VIEZEE; A. A. WARD; MUDLR. MUTTU WELLOPILLAI; K. BALASINGHAM; DEWA RAJAN; HACKETT THOMSON; DIRECTOR OF AGRICULTURE, Jesselton; DIRECTOR OF AGRICULTURE, Kuching; H. WILKINSON; HON. MR. CHAS. VANDERWALL; MOHAMMED FARID MOUNIB; ABDUL HAFIZ NOSAY; W. J. AGER; E. M. WYATT; P. S. SHERDRAKE; HAROLD DE ZYLVA; T. W. OLIVER; DEPUTY SUPERINTENDENT OF SCHOOLS, Zamboanga: R. A. DUMMER; W. A. MUTTUKUMARU; DE HANDELSVEREENIGING LE BATAVIA; M. S. FERNANDO; E. H. M. WIJEYESEKERA, J. H. BAHAR, Mudaliyar; and T. CHELLATURAI, the total number of members at date being 1,576—890 local and 686 foreign. The foreign members are drawn from England, 71; Scotland, 8; Ireland, 4; New Zealand, 3; France, 13; Siam, 6; Italy, 4; Burma, 37; Java, 44; Japan, 23; Fiji, 4; Belgium, 2; India, 144; F. M. S., 80; Portugal, 3; China, 2; Russia, 2; Cochin China, 5; Africa, 50; America, 25; Australia, 35; East Indies, 6; West Indies, 29; Pacific Islands and Hawaii, 8; New Caledonia, 1; Egypt, 6; Bahamas, 1; Gold Coast, 12; Holland, 7; Dutch East Indies, 9; Philippine Islands, 2; Solomon Islands, 7; Mauritius, 4; Seychelles, 5; Borneo, 14; Uganda, 9; Cook Islands, 1; of Local members, 336 belong to the Western Province; 254 to the Central Province; 72 to the Southern Province; 40 to the Northern Province; 40 to the North-Western Province; 59 to the Province of Sabaragamuwa; 15 to the Eastern Province; 17 to the North-Central Province; 57 to the Province of Uva.

Starting with a membership of about 100 in 1904, the number steadily rose to 1,883 in 1914.

Since the outbreak of the war the names of members who were enemy subjects were deleted from the Society's register, whereby the number was reduced by about 300.

BOARD.

We extend a hearty welcome to SIR JOHN ANDERSON as President ot the Board and feel sure that the Society will make steady headway in its career of usefulness under His Excellency's rule.

During the past year the Society lost one of its Vice-Presidents through the death of SIR HECTOR VANCUYLENBURG, M.L.C., who evinced a keen interest in its proceedings and was always ready to assist in any practical measure affecting the welfare of the indigenous population. SIR HECTOR was specially interested in agricultural education.

The announcement of MR. JOHN HARWARD'S retirement will be received with sincere regret by all members of the Board. MR. HARWARD has been closely associated with the work of the Society since its inception. He served on several Committees and made valuable contributions to the discussions at

Board Meetings. Indirectly he has rendered great service to the cause of agriculture through the hearty support he gave to the School Garden Scheme, which works through the organization over which he presides, and, but for his ready and willing assistance, could hardly have attained to that degree of efficiency which it has reached.

OFFICE.

Some idea of routine work of the office will be indicated by the following figures:—

Letters received	4,445
Letters despatched	4,358
Endorsements	588
Memos, Reminders, &c.	5,400
English Magazines despatched	20,472
Sinhalese Magazines despatched	30,204
Tamil Magazines despatched	1,560
Acknowledgments and Receipts	1,797
Total ...	68,824

As the Society is in touch with Agricultural Departments and Institutions in all parts of the world, a large number of enquiries on matters pertaining to Tropical and Sub-Tropical Agriculture are received from abroad in addition to local communications.

The clerical staff consists of Mr. J. S. DE SILVA, Chief Clerk, who joined the Society at its inception, and has a thorough grasp of the duties of his office, MR. W. A. W. GUNAWARDENE, Assistant Clerk and Interpreter, MR. K. B. HALANGODA, 2nd Assistant Clerk, and MESSRS. C. A. SAMARASINGHE and A. ABEYESINGHE, Junior Clerks. MR. W. MOLEGODE, Senior Agricultural Instructor, who is attached to the Secretary's office, is frequently deputed to conduct special enquiries and initiate experiments in different parts of the Island.

STAFF.

The Organising Vice-President presided at a number of meetings in the provinces, chiefly in connection with the Co-operative Credit movement, and enquired into local affairs at different centres. MR. LYNE's wide sympathies and practical advice have been of the greatest service to the Society.

The Secretary traversed all the provinces of the Island supervising the work of the Agricultural Instructors and inspecting the gardens and experimental plots established by the Society.

The following is a list of the Instructors, the number being kept down owing to retrenchment:—

WALTER MOLEGODE, Head Office.
K. CHINNASWAMIPILLAI, Eastern Province.
L. A. D. SILVA, Sabaragamuwa Province.
M. J. A. KARUNANAYAKE, Hambantota District.
A. MADANAYAKE, Galle District.
J. R. NUGAWELA, Central Province.
A. A. JAYASINHE, North-Western Province.
V. RAMANATHAN, Northern Province.

The services of MR. L. DE Z. JAYATILLEKE, Agricultural Instructor, Sabaragamuwa Province, were requisitioned as Interpreter to the School of Tropical Agriculture.

The appointment of MR. CHELLIAH, late Agricultural Instructor, Jaffna, as Maniagar of Delft and MR. P. B. M. BANDARANAYAKE as R.M. of Bintenne (Eastern Province), is a compliment which the Society duly appreciates, and it is hoped that the continuance of the policy of selecting headmen from the Society's staff of instructors will be justified by the improvements which such trained officers should be able to effect in their districts.

FINANCES.

The annexed statement of receipts and payments drawn up by the Society's Auditors covers the period January to December, 1915.

Though the year started with a small debit balance the Society's finances speedily recovered themselves as the result of increased income from subscriptions on the one hand and by retrenchment on the other and in spite of a reduced grant from Government, it was able to vote a sum of Rs. 1,200 for class-rooms for the School of Tropical Agriculture and Rs. 580 on account of extensions to the Office. As will be seen from the Statement of Accounts the year closed with a credit balance of Rs. 16,629·82.

INCREASING THE FOOD SUPPLY.

At a recent meeting of the Low-country Products Association this subject was referred to and strange to say no mention was made of the work done by the Society in this connection.

The Society is the only organisation in the Island with a staff of itinerating officers who are giving all their time to the improvement of native agriculture. They are in constant touch with the rural population, and have special facilities, which they have not been slow to take advantage of, for encouraging the extended cultivation of food crops. The Progress Reports of the Society have during the past 12 years been one long record of work done in distributing seeds of cereals, legumes and other edible crops as well as fruit plants, numbering many thousands. To those who move about the country, particularly in the remoter parts of the Island, the improvement on previously existing conditions as the result of the work of the Instructors, the influence of the Society's Gardens as well as of School Gardens is most striking. In the last Progress Report will be found a reference to Polonnaruwa and in the present report to Balangoda and Ambalangoda as places which supply abundant testimony of the good work that has been done by the Society. During the early days of the War, when a shortage in the food supply was apprehended, the prompt action taken by the Society materially helped to save the situation.

The question of bringing under cultivation the extensive irrigation areas lying waste under the tanks is a separate one and must be considered by itself. What is to be desired—at least as an initial measure—is that these lands should be given at nominal rates to individual capitalists or syndicates on condition that a certain proportion of the area is brought under cultivation every year. We have waited long enough for colonization by small settlers, and it is time a definite liberal policy was adopted, as in Australia, to induce those who have the capital to open up these lands and thus assist to colonise them, so that the Island's resources may be further developed and the railway route better patronised both for passenger and goods traffic.

Too great prominence is being given to paddy as the crop *par excellence* for cultivation under irrigation, and too little attention to other crops which under irrigation can be made to give large yields, as is the case

in India, Egypt and Japan. The Dry Zone Experiment Station at Anuradhapura under the management of MR. D. S. CORLETT has brought this home to us, and proved the possibility of establishing large irrigation farms under the tanks. It is to be hoped that all concerned will profit by the lesson which the Department of Agriculture has taught and that its practical application will be seen before long.

DISTRIBUTION OF SEEDS AND PLANTS.

One of the most important items of the Society's programme of work is the distribution of seeds and plants to members. The regular distributions take place in May and September. During the past year 7,400 packets of seeds and 4,831 plants were issued.

The Society's nurseries at Colombo contained 3,000 plants at the close of last year.

The seed store and nurseries so long associated with the Government Stock Garden in Colombo are now being transferred to the site of the old Silk Farm close to the Peradeniya Railway Junction, where they will be under the close supervision of the Secretary.

The duties of Seedsman to the Society are performed by MR. M. J. FERNANDO, who also holds office as Manager of the Government Stock Garden. I would like to take this opportunity of acknowledging the service rendered to the Society by this officer.

PUBLICATIONS.

The Society's Journal—THE TROPICAL AGRICULTURIST—maintains its reputation as the leading agricultural magazine in the Tropics. During 1915, 21,000 copies were issued containing 1,512,000 pages of actual reading matter.

MR. LYNE, Director of Agriculture, is Editor, with the Secretary as his Assistant, and articles of special interest are also contributed by the members of the Agricultural Department. Progress Reports of the Society are embodied in the Journal, which has every important agricultural magazine on its list of exchanges.

The Sinhalese Agricultural Magazine—GOVIKAM SANGARAWA—is the only local journal of its kind, and as such is very popular. It is now in its eleventh volume and has a monthly impression of 2,900. Copies reach the hands of all Teachers of Government Vernacular Schools, and most Headmen. The Secretary is Editor and is ably assisted by MR. N. WICKREMARATNE, Secretary to the Board of Control, Co-operative Credit Societies.

The Tamil Magazine—KAMAT THOLIL VELAKKAM—is edited by MR. C. H. COOKE. It is not as well supported by the Tamils as the GOVIKAM SANGARAWA is by the Sinhalese.

The more important papers read at Board Meetings are reprinted and distributed as leaflets.

A third edition of the Year Book is in course of preparation and will be issued at the end of the year.

MR. MOLEGODE, Senior Agricultural Instructor, has compiled a useful and handy little book on Vegetable Culture.

The following is a complete list of the Society's publications up to date: —TROPICAL AGRICULTURIST 22 vols., and 11 each of GOVIKAM SANGARAWA and KAMAT THOLIL VELAKKAM and leaflets dealing with the following subjects:— Agriculture in Tamil Districts; A Note on Onion Cultivation; Castration of Cattle; Canker (Nectria) of Para Rubber (Hevea Brasiliensis); A Note on

Chillie Cultivation; Yams (Dioscoreas); Prevention of Plant Diseases by Spraying; Kiushu or Japanese Paddy; On the importance of submitting specimens when reporting injury from Insect Pests; Bud Rot of the Coconut Palm; Hints to Cotton Cultivators; Useful Hints to Growers of Castor-Oil (Eri) Silk Worms; Rice Bug or Paddy Fly; Agri-Horticultural Shows; Shade Trees: their Importance, Instructions for Planting them, etc.; Dumbara Tobacco; Diseases of Tobacco in Dumbara; Use of Salt for Manure; Manioca Cultivation, Dhall; Method of Taking samples of Soil; Transplanting in Paddy Cultivation, The Improvement of Local Races of Plants; A Simple Preventive against Malaria; The Use and Object of Agricultural Societies; West Indian Yams; Conservation of Soil Moisture; Rotation of Crops on Chena Lands; Continuous Cultivation of Chena Land; Coconut Stem Bleeding Disease; A Stem Disease of Coconut Palm; Results on Recent Experiments in Paddy Cultivation; Groundnuts; Arrowroot; Further Notes on Transplanting and Manuring Paddy; Two Valuable Green Manures; Hints to Tobacco Growers; Silk Cotton Tree; Soy Bean; Notes on Grafting and Budding; Sorghum as a Fodder Crop; Some Hints to Village Coconut Cultivators; The Castor Oil Plant; Hints on Bee-keeping; Dry Farming; Fodder for Cattle; Hints on Cotton Cultivation; Continuous Dry Land Cultivation; Plantain Disease; Green Manure for Paddy; Sudan Dura; Address to the Students of the School of Tropical Agriculture; Report on College of Tropical Agriculture.

GARDENS.

The Society's Gardens continue to serve as agencies for the extension of fruit and vegetable cultivation and the dissemination of new and improved varieties of economic crops, in addition to being experimental and demonstration centres.

Through them many lessons have been taught and a great deal of practical experience gained for the benefit of local landowners.

The Garden at MEDIWAKE in Upper Dumbara has for the past four years demonstrated the practicability of continuously cultivating chena land by adopting a modified system of rotation. Through this garden better varieties of sweet potatoes, maize, tobacco and cotton have been introduced, and the cultivation of such new crops as spelt wheat, potatoes and coriander demonstrated.

The BANDARAGAMA Garden is mainly devoted to the cultivation of fruit, and a large and representative collection, numbering about 300, of both local and introduced varieties has been established. It is therefore an important centre for the spread of fruit culture in the south-west of the Island.

BALANGODA Garden has done much useful work in encouraging the cultivation of vegetables, which were notably scarce and dear in this district. Both Native and English vegetables have been systematically raised on a commercial scale and the seed freely distributed, with the result that the supply of vegetables is now plentiful. Such new cultivations as onions, sorghum, cow-pea, soy-bean have also been successfully carried on. The Garden having served its purpose, it is proposed to plant it with fruit trees and hand it over to the local authorities before starting operations in some other little-developed centre such as Godakawela.

The KEGALLA Garden and Park is laid out with ornamental and economic trees, and nurseries of plants for distribution. Seedlings of new varieties of hybrid coffee have been established and land has been cleared for planting them out.

At the WERAGODA Garden which serves the moist south of the Island, both fruit and vegetable cultivation is carried on. As a result of the work going on here the growing of vegetables has become a common occupation, while pine-apple cultivation has been taken up on a large scale. The propagation of the better varieties of fruits, both local and introduced, established in the garden is being successfully done by means of "Gootee" layers.

The AMBALANTOTA Garden is situated in the dry south of the Island. Here the cultivation of cotton and sorghum has been demonstrated and encouraged among holders of chena land, by whom both crops have been taken up and successfully raised. Cotton is admirably suited to the extensive waste lands of the Hambantota district, but in the absence of a local buying agency there is no encouragement to would-be cultivators. Sorghum is proving a desirable addition to the food supply of the district.

PADDY.

The Society's work in connection with paddy may be summarised as follows:—(1) the introduction of new and better strains, (2) effecting exchange of seed, (3) arranging for meeting shortage of seed, (4) demonstrating seed selection and the advantage of transplanting (5) proving the advantages of green-manuring, (6) making trials with improved types of implements.

Not much more than 5 years ago the planting out of paddy seedlings raised in a nursery was the exception in the neighbourhood of Kandy: now it is the common practice as the result of the work of the Instructors. By demonstration and trial plots and by the offering of awards, the cultivators are being gradually weaned from their old ways.

The reluctance to adopt new strains of paddy was at first a serious obstacle, but since the Instructors have won the confidence of the cultivators this difficulty has disappeared.

The cultivation of MOLAGU-SAMBA paddy, introduced from India in the latter part of 1912, has now spread far and wide. It is a fine table rice which suits local conditions, and is therefore a valuable introduction.

A detailed record of the Society's work in connection with paddy cultivation up to the end of 1914 will be found in a pamphlet issued last year. This gives an idea of the extent of the operations, and the results achieved.

Since then seven varieties of PHILIPPINE paddy were received and a first crop raised with the assistance of MR. K. B. BEDDEWELA. Some of these are so highly thought of that they are likely to become as popular as Molagu-samba.

The most recent introduction is a series of short-aged varieties, ranging from 2 to 4 months, procured from Burma, Travancore and Madras to meet the requirements of certain districts.

The growing of sunn-hemp as a green manure crop has been steadily encouraged and the results obtained have been so satisfactory that sunn-hemp is being widely grown for the purpose of manure. At Tissa the crop was doubled when it followed a crop of sunn-hemp, and at Ratnapura and Molegode an increase of 44% was effected by this means.

A "transplanting" demonstration was conducted, at the request of MR. GRAHAM PANDITESEKERA, a landowner of Chilaw district, at Madampe where transplanting was practically unknown. MR. W. MOLEGODE who

supervised the work was able to show a yield equal to 66 bushels per acre raised with 8 measures seed against the ordinary yield of 40 bushels per acre with 2 bushels broadcasted seed.

The following summary of a report of a recent demonstration made by MR. MOLEGODE at Dunuwile, Kandy district, embodies results not previously recorded. Mutusamba (6 months) was cultivated on a field approximately 7/10 of an acre in extent. Selected seed was sown in a nursery and the seedlings when 6 weeks old were planted out in bunches of three, which were placed 6" × 6" apart. The field, after ploughing and levelling, was treated with ordinary village refuse. The paddy attained a height of 6 to 8 ft. and gave a yield of 66½ bushels equal to 95 bushels per acre.

On Suduganga Estate (Matale district) with the co-operation of MR. R. SENIOR-WHITE a field of 1/17 of an acre was planted out with seedlings of Molagu-samba paddy, two seedlings per hole being planted 4 in. × 4 in. apart. The crop was excellent, each bush producing on an average 30 shoots. Unfortunately the crop was badly damaged by field rats owing to the neglected condition of neighbouring fields, and as a result a yield equal to only 25 bushels per acre was secured. A sample of the paddy raised is on view to-day.

On Marakona estate (Matale district) similar experiments in transplanting were conducted in co-operation with MR. A. B. THOMSON, the Superintendent, and proved that it was possible to double the ordinary yield by adopting the methods recommended.

These first experiments on estates will be repeated, and as the fields get settled down and the details of work become more familiar, better results may be expected.

The cultivation of water-resisting paddy obtained from Burma was conducted at Baddegama with the co-operation of MR. D. A. GUNAWARDENE who has furnished the Society with details as to dates of sowing, periods of inundation, etc. The crops gave good promise of resisting the effect of flooding, but the occurrence of an unusual drought nullified the results and more accurate information must await another season's work. Following upon a discussion at the meeting held in Galle, an enquiry was instituted into the circumstances under which fields in tidal areas along the South-West Coast are liable to be inundated by salt water and resulted in the following facts being elicited: (1) Inundation takes place during two seasons of the year, namely in June and December, when the paddy is from 8 to 10 inches high. (2) At such periods the incoming mixture of river and sea water floods the fields and leaves the water standing to a depth of from 4 to 8 inches. (3) The plants in the lowest fields die out as soon as the flood subsides; those in the higher elevations become yellow and give a very poor return. (4) No steps are taken to help the flood water to escape by cutting drains, etc. MR. CORLETT, Manager of the Experiment Station, Peradeniya, kindly undertook to consult the Ministry of Agriculture, Cairo, with a view to ascertaining what action was taken under similar circumstances in Egypt. The reply received was to the effect that no rice was cultivated under precisely similar conditions, but that salt lands were reclaimed for cultivation by deep ploughing and washing out the soil, so that the salt in it is precipitated to a lower level or passes out in solution into the drains cut low for the purpose of keeping the land sweet. If the drains are not cut low the salt is liable to again rise up.

The construction of dams to keep out brackish water would seem the most satisfactory, though expensive, way of meeting the difficulty.

In Western India special strains of paddy are cultivated on saline lands, and one of these (Dodki) is being grown experimentally in the Jaffna district by the AGRICULTURAL INSTRUCTOR and MUDALIYAR C. M. SINNAYAH.

COCONUTS.

The stoppage of trade with enemy subjects and the temporary dislocation caused by difficulty in securing freight caused considerable inconvenience for a time, but did not affect commercial confidence in the industry.

During the first quarter of 1915 the price of copra ranged from Rs. 70 to Rs. 81 per candy; in the second quarter it fell as low as Rs. 46; in the third it went up to Rs. 60; while in the fourth the price fluctuated to an extraordinary degree, rising to Rs. 94 in December but falling again to Rs. 75 before the close of the year.

The exports of copra during the year aggregated 1,098,174 cwt.; of coconut oil, 473,425 cwt.; desiccated nut 37,844,694 lb.; poonac 184,897 cwt.; coconuts 5,443,677; yarn and fibre 277,104 cwt.

Two lots of San Ramon coconuts have been imported by the Society at the request of enterprising members. PROF. COPELAND in his standard work on the Coconut describes this nut as very large and productive and states that the average production, year after year, is 1 picul of copra from every 200 nuts which is equivalent to 818 nuts per candy.

Some 250 nuts received on the order of the Society have been distributed among 12 members, the largest number going to MESSRS. C. NAMASIVAYAM, Colombo, V. CASIPPILLAI of Jaffna and F. J. DE MEL of Moratuwa, who received 50 and over each.

The introduction of this excellent variety of the coconut is a notable event in the history of the industry.

TOBACCO.

The possibility of our producing a tobacco good enough for the European market is receiving the close study of MR. SCHERFFIUS, who has now worked through two seasons in the North.

It is to be hoped that he will next turn his attention to Dumbara and Matale districts, where tobacco cultivation is fast extending and the prospects of growing a superior leaf for export purposes are distinctly promising.

SORGHUM.

The experimental cultivation of Sorghum *(S. vulgare)* was first taken up by the late Colombo School of Agriculture as far back as 1888, when it was regularly grown in the students' plots and found its way from there to the chenas; but it was never taken up in earnest and only appeared in highland cultivation as one of the ingredients in the mixed crops which generally characterise chena lands.

Sorghum vulgare is known by different names in various countries where slightly differing strains of the cultivated species are found. It is the Giant Millet of India, the Guinea corn of the West Indies, the Dhura of Egypt, the Kaffir corn of South Africa, the Broom corn of Italy, and so on.

In India it occupies some 25 millions of acres and is important not only as a grain but also as a fodder crop, and in the dry condition it is the stand-by of the cattle owner whenever there is a shortage of pasture.

The successful cultivation of Egyptian sorghum by MR. CORLETT, Manager of the Experiment Station, Peradeniya, led to a revived interest in this crop, and by the distribution of seed through the Society its cultivation is being encouraged and a fairly large extent devoted to it in the drier districts for which it is specially suited, e.g. Hambantota, Jaffna, Batticaloa, Trincomalee, Anuradhapura, and parts of Badulla and Kandy districts. The people have yet to acquire a taste for the grain and adopt it in their dietary in preference to Kurakkan and other small millets they have so long been accustomed to. A paper on Dhura Cultivation by MR. CORLETT is available as a Society leaflet and applications for seed and instructions for planting should be made to the Secretary.

LAC.

In 1911 the Society, on the suggestion of PROF. DUNSTAN of the Imperial Institute, sent an Agricultural Instructor (Mr. N. WICKREMARATNE, now Secretary to the Board of Control, Co-operative Credit Societies) to the Agricultural Research Institute, Pusa, to study lac cultivation. On his return experiments in the cultivation of the Indian lac insect (*Tacchardia lacca*) were set on foot with the hearty co-operation of Mr. K. B. BEDDEWELA who rendered valuable assistance in this connection by offering trees on his estate for inoculation and also personally supervising the operations. The lac produced as the result of these experiments was distributed among lacquer workers in the Kandy and Tangalle districts, and some lacquered articles on view to-day have been prepared with this lac. A fresh lot of brood lac has been indented for from India, and further inoculation work in Jaffna, Kurunegala and Tangalle will be undertaken on its arrival. The lacquer industry has recently been in a very depressed condition owing to the difficulty experienced by the workers in procuring lac, which has hitherto been collected from the jungle, but it is to be hoped that the Society's efforts to establish lac on such common and practically useless trees as Kön (*Schleichera trijuga*) and Masan (*Zizyphus jujuba*) will result in its revival.

SERICULTURE.

Silk worm rearing has been practically given up except by the Salvation Army in connection with the Home for Vagrants in Mutwal.

The industry was never seriously taken up in the villages, though for a time the efforts of the Society resulted in temporary activity in this direction, particularly among school children.

The mulberry plantation on the late Silk Farm (now the site of the Government Stock Garden and Society's Seed Store and Nurseries) is still maintained and will be available for feeding and propagation purposes whenever sericulture comes to be revived. The breeding of both the mulberry worm (*Bombyx Mori*) and the Eri or castor-feeding worm (*Attacus Ricini*) is kept up on a small scale to meet any demand that may arise for eggs. Recently a case of cocoons was despatched to the Philippines at the request of the Department of Agriculture there.

APICULTURE.

Bee-keeping is practically confined to the rearing of the tropical honey bee (*Apis indica*) which is a good honey producer and takes readily to the box hive. There is, however, still much to learn about its manipulation particularly in checking its propensity for swarming which often takes place

unexpectedly and causes great disappointment to the bee-keeper. The manufacture of comb-foundation with the aid of the machine specially made for the Society in America, has undergone considerable improvement as the result of experience, and applications have been received for the material both locally and from India. Specimens of foundation are on view to-day. Applications for hives and swarms continue to be received at intervals, but when those who grow fruit crops - whether a commercial product like coffee or orchard fruit like oranges—fully realise the important part played by the bee as a fertilising agent, the rearing of bees according to modern humane methods and the gathering of honey without wanton destruction of bee-life, should become as common a home industry as poultry-keeping.

AGRICULTURAL EDUCATION.

Since the last annual meeting was held a School of Tropical Agriculture has been opened and is now at work at Peradeniya, the more ambitious scheme for an Imperial College having been postponed for a more favourable season

There are at present 72 students on the register, about half of whom are provided with hostel accommodation.

It will be recalled that the first steps towards the opening of a School or College of Agriculture were taken by the Society which has closely identified itself with the subject of agricultural education. In the equipping of the school the Society was able to provide two temporary class-rooms at a cost in material and money of not less than Rs. 1,500.

The appointment of the Organising Vice-President as Principal and the Secretary as Vice-Principal is a further link to bind the Society to the School.

The training of a number of Government vernacular teachers at the School will ultimately qualify these officers for teaching elementary agriculture to the village school boy through text books and School Gardens and thus widen the present scope of the School Garden Scheme which is doing such excellent work.

A senior agricultural reader, supplementary to the junior reader published in 1914, was prepared by the Secretary and has been adopted in Government Vernacular Schools.

IMPROVEMENT OF LIVE STOCK.

A good deal of work was done in the early days of the Society with the assistance of the Veterinary Department to eliminate as much as possible the undesirable males in village herds.

The improvement of stock by means of good breeding sires has however been so long left to private owners of live stock who have done much in this direction, but village cattle especially in outlying parts of the Island have received little attention.

In 1914 the Society by way of experiment imported a pedigree Kangayam bull through the Madras Department of Agriculture, and after keeping it for a time in Jaffna moved it to Ambalantota, and then to Mahaoya. The offspring of this animal is evidence of what is possible even on a small scale in improving the ordinary type of village cattle. Further efforts of this nature are desirable, and the purchase of selected bulls for particular areas (e.g. Delft) is under consideration.

With the formation of Co-operative Credit Societies in villages there is better opportunity for organising the improvement of cattle by employing suitable stud bulls.

Through the initiative of DR. H. M. FERNANDO, a scheme for the improvement of village poultry, through the agency of teachers in charge of School Gardens has been set on foot—the funds for the purpose being generously provided by him.

The HON. SECRETARY of the CEYLON POULTRY CLUB who was consulted with reference to this Scheme and kindly offered any assistance he could afford to make it a success, wrote as follows:—

> "I am very pleased to see something is being done to improve poultry throughout the villages. There is already a very marked improvement in poultry kept by natives in all up-country districts. This can be noticed motoring through the country, and I put it down largely to the efforts of members of the Ceylon Poultry Club who have I hear given a large number of eggs and birds to coolies on estates."

AGRICULTURAL SHOWS.

The Society since its formation has organised a long tale of Shows, but since the All-Ceylon Exhibition no Agricultural Show was held—chiefly owing to the war—till last April. The Nuwara Eliya Show which used to be an annual event did not take place last year, but this year a small Exhibition chiefly of flowers, fruits and vegetables was held on April 24th and 25th and was practically confined to the town and its environs. Though the classes were not as full as they might have been, many of the exhibits were of a high order. The Exhibition was opened by H. E. SIR JOHN ANDERSON.

An Agricultural and Industrial show to be held at Jaffna next year is on the cards, and if the proposal materialises this will be the first held in the Jaffna peninsula, and should prove an interesting exposition of what the industry of the inhabitants of the North can produce under tolerably hard natural conditions.

There is not likely to be another big show while the present political troubles last.

VILLAGE AGRICULTURAL UNIONS.

With a view to working hand in hand with the cultivator in order to effect the improvement of his crops the Society is initiating a system of Agricultural Unions—particularly in the remoter districts—through the agency of its Instructors.

The following note will give some idea of the working of these Unions.

Each Union will control a limited and compact number of villages and work a small farm of its own for which the land will be leased or acquired. The capital of about Rs. 500 will be raised by means of, say, Rs. 10 shares of which each member must take at least one.

(1) A small area of about an acre for testing new varieties which the members in consultation with the Agricultural Department may wish to try.

(2) The rest of the land to be devoted to the raising of pure seed of the variety which is proving most satisfactory.

The activities of the Farm will be devoted to the chief crop of the locality.

The produce of the seed of the Farm will be sold each year to the members, each of whom will reserve a part of his own land for growing the seed from the Union Farm and reserve the produce for his own use. By this means each member will be increasing his supply of good seed so that in time the whole of his land will be sown with the best available seed calculated to produce the highest yield.

The Union will consist of members who reside not further than a specified radius, say 5 or 6 miles. The Farm will be controlled by a Committee and be in direct charge of a Manager responsible to the Committee. A simple set of accounts showing receipts and expenditure will be kept.

The Union should be registered as a Co-operative Union under the Registrar of Co-operative Credit Societies, in which case it will have its accounts properly audited.

A reserve fund will have to be formed to provide for *(a)* partial failure of crops, *(b)* renewal of stock live or dead, *(c)* contingencies of any kind.

A similar system of Unions tried in North India is working well and helping to improve the wheat crop.

The Farm will be the means of introducing new varieties and demonstrating new methods.

The chief element of success in the working of the Farm is that every member of the Union will have a personal interest in its success or failure for if it makes a profit he benefits thereby and vice versa.

Specific details (size of farm, capital, value per share, etc.) will of course be influenced by particular localities, but the principles of the system will be the same everywhere. The greatest care will have to be taken that the element of risk (particularly in trying new crops and methods) is reduced to a minimum, and that as far as possible the success of any undertaking is assured. The main object in view should be to benefit the great mass of cultivators by effecting the improvement of seed which receives practically no attention. By means of these Unions the village cultivators will be co-operating for their own benefit.

PESTS AND DISEASES.

The cordial relations existing between the members of the Agricultural Department and the Society has made it possible for the members to avail themselves of the expert advice which the scientific officers can afford them.

The Acting Entomologist, MR. GEORGE HENRY, whose advice was the most frequently sought, reported on various pests causing damage to paddy, mango, orange, cinnamon, tobacco, sorghum and vegetables, and the Society rendered assistance to those in need of help to carry out remedial measures. Full particulars of these pests and the treatment suggested are embodied in the Progress Reports and reproduced in the TROPICAL AGRICULTURIST.

It is much to be regretted that no practical means of fighting the plantain disease which first appeared in 1914 have yet been discovered.

A landowner who has given special attention to plantain cultivation writes :—

> "I am sorry to say that the imported plantain varieties you were kind enough to give me from the Stock Garden some time ago, are no more, having been attacked by the plantain blight, and the two varieties I sent to the Stock Garden seem to have shared the same fate. I had about 22 varieties of plantains on my estate at Talangama and there are only just a few remaining owing to the blight, to eradicate which we have up to date found no effective treatment."

CO-OPERATIVE CREDIT SOCIETIES.

All the spade-work in connection with this movement was done by the Society before a staff was appointed in 1913 with MR. R. N. LYNE

as Registrar and MR. N. WICKREMARATNE as Secretary. In 1914 a largely attended conference was held at the King's Pavilion, Kandy, presided over by HIS EXCELLENCY SIR ROBERT CHALMERS. There are now 55 registered Societies with a membership of 4,800 and a paid-up capital of a little over Rs. 25,000. The main object of these Societies is to help the villager by lending him money at a low rate of interest to efficiently carry on his agricultural pursuits. Much good has also been done by local Societies purchasing and retailing manure to members on easy terms. During 1915 and in the first quarter of 1916 about 81 tons of manure purchased at a cost of about Rs. 8,450 have been distributed among the members by 12 Societies. The bulk of the manure was for paddy land.

Several of these Societies are interested in the improvement of paddy cultivation and with the assistance of the Agricultural Society are making trials with new strains of seeds, in transplanting, etc. The starting of gardens has been proposed by more than one Society, and it is hoped that these will be established before long. In India the question of amalgamating the departments controlling Co-operative Credit Societies with the Agricultural Departments has been under consideration. In Ceylon the Government anticipated this idea by appointing the Director of Agriculture as the head of the Co-operative Credit movement.

Owing to local and foreign disturbances this movement has not progressed as much as it should have done during the past year.

It is to be hoped that the members of this Board will do everything in their power to increase the number of Co-operative Credit Societies and thus help those who are in real need of assistance.

A RETROSPECT.

The Society was founded by SIR HENRY BLAKE in 1904 and was, so to speak, set on its feet by SIR HENRY MCCALLUM.

The first Secretary of the Society was MR. E. B. DENHAM, C.C.S., who held office for two years during which time he did yeoman service. He was succeeded by the late lamented MR. A. N. GALBRAITH, C.C.S., who acted for 6 months, after which the post was held for a short space of 2 months by MR. T. A. CAREY, C.C.S. In 1907 the present Secretary was appointed in addition to his own duties as Superintendent of School Gardens.

Since then the staff of instructors, originally 3 in number, was increased to 12, but owing to retrenchment the vacancies created by the appointment of instructors to other posts have not been filled up, and at present the number is down to 8.

The work carried on through the Society's gardens, as well as through the instructors and the Sinhalese Agricultural Magazine has created a keen and intelligent interest among native cultivators in everything pertaining to agriculture which, if that were all achieved, is in itself a great work.

In its instructors the Society possesses a number of trained and tried officers whose knowledge of the cultivating classes and the conditions under which they live and work as the result of close and frequent contact with them, is of the greatest value in attempting to carry on any work of improvement.

I would specially commend their case to the sympathetic consideration of the Board, inasmuch as it was not dealt with by the late Salary Commissioners, and would urge that their scale of emoluments be revised and their prospects so improved as to be in keeping with the times and commensurate with the value of the technical services rendered by these officers.

C. DRIEBERG,

6th June, 1916. Secretary, Ceylon Agricultural Society.

TROPICAL AGRICULTURE UNDER IRRIGATION.

(Paper read before the Annual Meeting of the Ceylon Agricultural Society, June 6th.)

In several of the oldest civilised countries of the world, vast tracts of land that once supported a teeming and prosperous population have fallen back into their primeval state of desert, marsh or jungle. In such countries as Egypt, Mesopotamia, and Ceylon, this has been probably caused by the failure, for one reason or another, of their great irrigation works, created when the nations concerned were at the zenith of their power.

Since those days Egypt, under British administration, has been entirely restored to her former state of wealth and prosperity by the restoration of her Irrigation Works. Mesopotamia, under the desolating rule of the Turks, still lies waste; but the day is perhaps dawning when she too will resume her power with the reconstruction of her irrigation. Now let us briefly see what has been done in Ceylon, and what could be done, to restore her northern provinces, which were once the richest in the East, back to their former wealth.

Here in the Northern part of the Island lies a vast tract of jungle-land in a semi-dry zone, receiving rain in only one monsoon. The soil is fertile and mostly flat and capable of irrigation from the great artificial tanks built 1500 years ago and since neglected and ruined. Under various administrations, since that of Sir Henry Ward in 1855, the Government of Ceylon has spent large sums of money on the restoration of many of the greater tanks and their channels, as well as the smaller village tanks they feed.

The sum thus invested is a large one and the annual expenditure on upkeep of the works is considerable, but the income derived is small in comparison.

With this fertile land and abundant water the return on the irrigation works might perhaps be made to show a profit.

The schemes of restoration have had for their object the improvement and extension of paddy-cultivation by native cultivators—partly for the relief of the scattered villagers already in possession of land and partly to induce settlers from other provinces. A later idea amongst planters on a larger scale is that Ceylon should attempt to reduce the price of imported rice from India and Burma by planting up the vast areas in paddy.

The importation and the price of rice is ever on the increase, to feed the increasing population, whilst the home cultivation of paddy is on the decrease.

But the price of rice can never be ruled by what could possibly be produced in the limited areas of the paddy fields of Ceylon. The price must be ruled by the vast areas of India and Burma where it can be produced at a cheaper rate. Just so is the price of wheat controlled by Russia or Canada, or cotton by America.

In order to insure the financial success of modern irrigation works, they should produce staple products of high value, besides less profitable crops such as paddy and other grain.

In Egypt the cultivators look to pay their taxes, water-dues and heavy cultivation expenses from their lucrative crops of cotton or sugar-cane, leaving the crops of paddy or maize as net profit.

But the native goiya of Ceylon has very little knowledge of proper cultivation under irrigation. It would take generations of tuition before he would adopt modern methods or could be induced to make his land produce more than just sufficient for his own needs.

We have before us the example of what has happened under Tissamaharama Tank in the South. For twenty years the natives have been cultivating this fine, large area of good soil and abundant water, yet we find a most poor form of cultivation producing a quarter of the crops it is capable of producing. Labour is scarce and the settlers are beset with difficulties.

And nowhere in Ceylon—save perhaps in Jaffna—is there a surplus population seeking an outlet for its energies in taking up and cultivating new lands reputed unhealthy and requiring a considerable outlay in preparation before they are fit for cultivation.

Thus it would appear that the successful settlement of these valuable lands by the unaided efforts of the goiya of Ceylon is not likely to take place.

Let us then see what alternatives could be adopted.

If we abandon the idea of paddy cultivation alone, what crops suitable to irrigation and the climate remain?

It has been proved at Maha-iluppalama in the centre of this district, that the coconut palm, under proper cultivation and with irrigation, can be successfully grown. The palms take from six to eight years to bear, but meanwhile there is a wide field for catch-crops available.

At the New Anuradhapura Experiment Station, which two years ago was a waste of jungle, is now to be seen a large variety of valuable economic products. Tobacco; Robusta coffee; Sugar-cane; Cassava; Arrowroot; grain and Leguminous crops of all kinds; Citrus; and other fruit trees, and many other products. There is also the possibility for cocoa and oil palms.

To establish any or all of these products successfully would entail considerable expenditure in clearing, levelling and preparing the land and creating field-canals and drains subsidiary to the main irrigation channels. Secondly some time must elapse before a profitable return on the outlay could be expected.

It is, therefore, obvious that either the aid of the Government or the capitalist must be called in.

Firstly there is the Planting Company. The objection to this scheme that has been raised is that it only benefits the capitalist and the Tamil labourer, to the exclusion of the Sinhalese.

But when once plantations are established with hygienic, mosquito-proof lines, work will be found for inhabitants of neighbouring villages, and labour from the Eastern Province and Jaffna will be readily attracted. Plantations must mean employment for educated Ceylonese and openings for traders of all kinds.

Secondly there are Land Companies. Those in Egypt have done a great work in forwarding the prosperity of the people and adding vast tracts to the domains of Egypt and the Empire. And as such they have received every support from the Government. But in Egypt there is a large population to settle on new lands and before any such company ventured in Ceylon either an indigenous or Indian immigration must be assured to settle on the land when developed. The company prepares the land—a matter of several years—and establishes it in crops of paddy, dura, sorghum, legumes and other local products. The land is then leased to native cultivators and gradually sold to them together with the hygienic villages built by the company.

In 1912, I understand that practical proposals had been put forward for developing land under some of the tanks, though I do not think anything has as yet come of them.

DUDLEY S. CORLETT,

6th June, 1916. Manager of Experiment Stations, Ceylon.

THE FUTURE OF RURAL AGRICULTURE IN CEYLON.

(Paper read before the Meeting of the Ceylon Agricultural Society on June 6th.)

The agricultural industries of the Island fall under two distinct heads, viz.: the Planting industry, which deals with the growth of products on an extensive scale for purposes of export, and the rural Agricultural industry, which is concerned with the growth of food crops required for the immediate use of the people. Rural agriculture in the aggregate deals with a larger area of land than that devoted to Planting products. The production of rice, dry-grains, vegetables and fruits is mainly confined to the peasantry who are small land-holders.

Rural agriculture has admittedly failed to progress with the times; in the main the same crops are grown and the same methods practised which were in vogue for hundreds of years. There is little progress to record. On the other hand owing to various economic changes in the country, the conditions under which these operations were carried out have considerably altered. The area of land available for cultivation is becoming restricted; the forest reserves which were available to the cultivators have been appropriated; the extensive tracts of pasture land for cattle have disappeared; and ancient village systems and methods of co-operation no longer exist in their original form. Rural agriculture has gradually become less profitable and the production of the soil has appreciably decreased.

The improvement of the methods of rural agriculture is a problem that still awaits solution. Various attempts have been made during the last thirty years to induce the cultivator to better himself, but the measures adopted to this end have not met with any marked success.

It will be interesting to recall some of these measures—

1. The restoration of irrigation reservoirs.
2. The establishment of a School of Agriculture in Colombo.
3. The teaching of agriculture in village schools.
4. The opening of experimental gardens.
5. The introduction of new crops.
6. The introduction of new breeds of cattle and the opening of a Dairy.
7. The establishment of the Ceylon Agricultural Society.
8. The organization of the Department of Agriculture.
9. The Scheme of School Gardens.
10. The introduction of the Co-operative Credit movement.
11. The founding of a School of Tropical Agriculture.
12. The working of an experiment station in the Dry Zone.

Some of these measures have been abandoned, others are still in existence and are being worked with the knowledge of past experience.

A number of irrigation reservoirs were restored at great cost and, in the case of two or three schemes such as those of Kalawewa and Tissa, a fairly large area of land has been brought under cultivation; but in other places such as Minneriya and Giant's Tank the land has not been taken up to any appreciable extent. The School of Agriculture established in Colombo in 1884 was discontinued after a few years as it failed to attract the proper

class of students. The teaching of agriculture in village schools was abandoned as not being of a sufficiently practical character. The Experimental Gardens opened from time to time were given up as they failed to interest the public. New products such as Cotton and Groundnuts were introduced as cultivations likely to benefit the rural population, but they never gained a footing. The Government established a dairy farm and also introduced new breeds of cattle from India. These did not result in any great extension of dairy farming or improvement of native stock, on account of the absence of suitable pasture land in the villages.

The agencies which at present aim at the improvement of the village cultivator are the Ceylon Agricultural Society with its staff of instructors and the Department of Agriculture which controls School Gardens, Co-operative Credit Societies, the School of Tropical Agriculture and the Dry Zone Experiment Station.

The causes of failure of some of the measures adopted for the improvement of rural agriculture deserve careful study in deciding the future agricultural policy of the country.

The causes of these failures may be broadly summarized under the following three heads:—

1. Much of the experimental work and instruction failed to influence the cultivator as they were in many instances adopted without an intimate knowledge of the rural population and belonged to an entirely different system of farming and different conditions of rural life.

2. The village cultivator has no capital or credit to enable him to carry out improvements in his system of cultivation and he has generally no means of earning money by engaging in subsidiary industries which at one time enabled him to supplement his income.

3. The system of rural administration under which the villager is placed has made him so dependent on outside assistance and interference in his affairs, that he has fallen into a state of lethargy and inactivity through which he has lost his powers of initiative and originality.

In any scheme for the improvement of rural agriculture in Ceylon measures should be directed to remedy these fundamental drawbacks. The Indian Department of Agriculture after several decades of experience has organised its staff of expert officers, with a view to enable them to gain as much intimate knowledge of rural conditions as possible. The experts who have received their training in the West are associated in each of their departments with deputies and assistants, who are natives of the country. These assistants are not foremen or members of a subordinate class of officers but are qualified men who act as colleagues and whose emoluments, status and education entitle them to a position little if at all inferior to the experts appointed from Europe. If the Ceylon Department of Agriculture will follow this Indian precedent it will greatly add to its value and usefulness.

The Tropical School of Agriculture recently started at Peradeniya has recognised the importance of imparting agricultural knowledge to the rural population, and has made provision for teaching the subjects in the vernacular where necessary. The English-speaking students who have joined the school belong to a class that is interested in the planting rather than in rural agriculture, whether as estate owners or as employées. Rural agriculture will have

to depend mainly on the students taught in the vernacular. Great encouragement should therefore be given to attract these latter students in large numbers. All vernacular teachers should be given a finishing course at this institution and sons of rural headmen and owners of village lands should be encouraged to attend the school by being granted free tuition and lodged at a cheap rate. The second difficulty which has been mentioned—the lack of capital and credit among the village cultivators—should be met by an organised effort for reviving village industries and encouraging them in every possible way. Societies similar to the Kandyan Art Association should be started in every important centre, and receive strong local patronage.

The Department of Agriculture is taking a keen interest in the formation of Co-operative Credit Societies and these efforts should be recognised by the public and every help afforded to make the scheme a success. As regards the third drawback, it is important that an exhaustive and careful investigation should be undertaken in regard to methods of rural administration so as to discover and remove the causes that have led to the stagnation of rural enterprise. The village cultivator should if possible be freed from the benevolent interference which has made him so passive and apathetic, and be urged to realise his responsibilities and shape his destiny through his own effort.

The Ceylon Agricultural Society through the untiring efforts of its Secretary and the sustained interest taken in its development by the Organising Vice-President and the other officers of the Society has without doubt been instrumental in creating very wide interest in agricultural matters in this country, and has opened the way for much useful progress in the future.

W. A. DE SILVA, J.P.

Colombo, 6th June, 1916.

THE AGRICULTURAL POSSIBILITIES OF DELFT.

(Paper read before the Annual Meeting of the Ceylon Agricultural Society.)

Delft (called the Long Island by the Tamils) is about 25 miles from Jaffna and 16 from Kayts, that is as the crow flies, but not as the boat sails. Indeed the journey to and fro has a spice of adventure about it, since it is seldom that the wind favours both the outward and inward bound passenger, and as likely as not what should be a journey of hours is sometimes prolonged by adverse winds to one of days.

The Island, which like the Jaffna Peninsula is of coral formation, is about 18 square miles in extent and nearly twice as long as it is broad.

The peculiar system of land tenure in Delft, unlike that of any other part of Ceylon, is thus referred to by MR. J. P. LEWIS, late Government Agent of the Northern Province, in his Notes on Delft (Royal Asiatic Society's Journal, Vol. XXII, No. 62):—

> "The island is the property of the Crown, and the people are tenants of the Crown: but the term of occupation is of indefinite duration, and no rent has ever been imposed or recovered, except for dry grain cultivation on the plains. Notwithstanding the fact that the inhabitants who occupy lands are merely tenants-at-will, they have during British

times at least been accustomed to make and receive transfers of these lands and to give dowries of them by notarial deed, as if the dominion was vested in themselves and not in the Crown. Up to the present year in Delft no lands had ever been sold by the Crown by public auction. In 1905 I recommended that some lands be put up for sale, and I am glad to see that course has now been taken, and some acres were put up for sale this year (1908)—the first sale of Crown land in Delft by public auction."

The characteristic perennial vegetation is similar to that of the Mainland and consists of the palmyrah palm planted in irregular groves. The palmyrah supplies the people with most of their wants.

Coconut cultivation is carried on on a limited scale, and in 1905, 50 candies of copra, 20,000 nuts and 10,000 cadjans were exported from Delft to Jaffna. Since then the area under coconuts has increased, and every inducement should be given to further extend the cultivation of the palm which with better attention ought to yield very good returns.

Annual food crops consist of tobacco, paddy and the following dry grains :— Sami (*Panicum miliare*), Varaku (*Paspalum scrobiculatum*) and Mondy (*Panicum Crus-galli* var., *frumentaceum*).

Tobacco occupies a small acreage, and by selecting sheltered situations and giving careful attention to details good leaf is produced for the Jaffna market.

Paddy cultivation is also of limited extent and is, of course, rain-fed.

The bulk of the cultivated land is under dry grains occupying between 2,000 to 3,000 acres, and there is a possibility of introducing better varieties of high land crops which stand drought well. With a view to popularising the Egyptian variety of Sorghum known as Dhura, the Agricultural Society distributed seed in time for planting last season and during my stay in the Island (March 2nd to March 5th of this year) I made a point of inspecting the results and awarding a prize for the best crop.

In an account of the cyclone which swept over the Islands in 1814 reference is made to the damage done to crops of wheat and hemp. If there is no mistake about the identity of wheat, this suggests the possibility of growing the crop, a variety of which introduced from S. India has been raised with success in the drier part of Upper Dumbara. I propose to send seed of this spelt wheat to Delft for next season's planting.

The hemp referred to is probably sunn-hemp (*Crotalaria juncea*) found under cultivation in Jaffna and Chilaw and not Indian hemp (*Cannabis sativa*). Sunn-hemp is a source of fibre used for making fishing nets, and is also an excellent green-manure crop.

Cotton, which was at one time grown systematically, is now not cultivated. A degenerate form of the coarse short-staple Tinnevelly variety, of an extraordinary hardy character, grows promiscuously as a perennial, and the poorer classes pick the cotton and spin it into yarn which is used for making sail cloth. While in Delft I saw the ginning and spinning done, and am showing to-day a series of specimens from seed cotton to the fabric. Before the next planting season the Maniagar will receive an ample supply of seed of a hardy variety, such as Cambodia Cotton, which should give a better yield and produce better yarn.

A minor industry—if it could be called one—is the collection of a plant found growing wild on the Island known in Tamil as Kavoti, in Singhalese as Bodi, and botanically named *Psoralea corylifolia*. The plant is found in other parts of Ceylon but is nowhere held in such high estimation as in the North where its virtues as a green manure for tobacco are highly appreciated. Licenses to collect the plant are issued at Rs. 4 each license, and a boatload of dry Kavoti fetches as much as Rs. 100. An examination of the plant by the Government Agricultural Chemist was made for the Society. In the sun dried state the percentage of organic matter was 79·13 and of this 2·56% was nitrogen. An analysis of the ash showed 22·18% of potash and 26·30% of lime. The Government Chemist reports:—"It will be seen from above figures that the plant contains a fair proportion of nitrogen in the sun dried state. The best green manures contain about 3% nitrogen. The ash is present in the plant in large proportion, but it will be seen from the ash analysis that the sand and insoluble amount to over 25% of the total ash, showing that a good deal of soil adheres to the plant after washing, so that to arrive at the true percentage of ash in the plant, the percentage of ash ought to be reduced by about 25%, and the constituents in the ash analysis ought to be increased by that amount. The plant is a greedy feeder of potash and lime, and would be useful in drawing supplies of potash and lime from the subsoil which would be given to the surface soil when the plant is mulched as a green manure.

Writing in 1903, MR. J. P. LEWIS remarks there is an excess of cattle in Delft, and states that in 1903 there were about 5,500 head of cattle, 3,000 sheep and 2,000 goats.

In the Jaffna Gazetteer, published recently, the figures given are 5,644 cattle and 3,980 sheep. I am inclined to think that the numbers are greatly in excess of these. The omission of goats (of which there are a few thousand in the Island) is strange. The small number of buffaloes in Delft is remarkable. MR. J. P. LEWIS gives the number as 137 and the Gazetteer does not mention any. At present there are probably less than a hundred but they are good specimens. The males are said to be in demand and to their removal is probably due the paucity of numbers.

That the number of cattle is excessive there is no question, but the degeneration of the stock is due I think more to promiscuous in-and-in breeding than to the inadequacy of the pasture. It is desirable that something should be done to check the progress of this degeneration which, as MR. J. P. LEWIS remarked in 1903, is reducing the cattle to the size of large dogs.

The demand for sheep and goats unfortunately does not extend to cattle. To effect improvement a weeding-out of about half the number, representing the worst types, should if possible be carried out in the first instance, and of those left all the young males except the best should be emasculated when about a year old: but what would be better still is to eliminate all bulls of breeding age in the process of weeding out, periodically emasculate all male calves and introduce a number of suitable stud bulls. These stud bulls should be carefully selected. It will not do to introduce Sind or other large stock. To begin with young animals of comparatively small build, but hardy and active, should be mated with the undersized cows. It may be possible to procure

animals of this type locally, from Panadure or other districts where a fine type of small bull is to be seen: if not, they could be brought over from India.

I would commend these suggestions to the Government Agent of the Northern Province who can count upon the co-operation of the Society in any steps he may take for the improvement of cattle in Delft. A similar course might also be adopted with regard to sheep and goats.

Delft has always been associated with the breeding of horses, which was begun by the Portuguese (who called it the Isle of Horses) and continued by the Dutch. After a period of neglect the British Government took steps to revive horse-breeding at the end of the eighties but finally abandoned the attempt in 1906. The decision to do so was probably arrived at on the advice of the Government Veterinary Department under whose supervision the breeding operations were conducted.

The 25 or 30 animals left on the Island are a great improvement on the old type of Delft pony.

The most interesting feature of Delft is undoubtedly its pasture lands, nearly 5,000 acres in extent. There is probably nowhere in Ceylon such a luxuriant growth of nutritious grass.

Some people have an idea that the natural herbage in Delft is mainly composed of what is commonly known as "Delft Grass." This latter is a species of Cymbopogon (*C. polyneuros*) containing an essential oil with the odour of anise. It probably was named after Delft owing to its having first been noticed there. It is by no means common there and occurs in other parts of Ceylon. The pasture in Delft is composed chiefly of a very fine variety of *Cynodon dactylon* or common horse-grass which grows with extraordinary vigour and covers the ground like a pile carpet. The grazing areas suggest a supply of underground moisture enabling the grass to preserve its luxuriance, which probably arrested the attention of the Portuguese settlers of the North. One cannot think of any means of improving upon this natural pasture, and the only cause for regret is that better control is not exercised over the stocking of the land with a view to making the best use of, and securing the best results from, these rich grazing areas.

The common method of enclosing land (not seen elsewhere in Ceylon) is by means of dikes or stone walls as seen in parts of Scotland and Ireland. These dikes are very roughly constructed of chunks of coral stone, placed one on top of the other, and in this way large rectangular paddocks for livestock and smaller circular ones for cultivation purposes are constructed.

There are many other interesting features worth noting about this quaint little Island but they would be out of place in a paper written from an agricultural standpoint.

I am glad of the opportunity afforded me of visiting Delft, and I entertain the hope that with the local administration in the hands of a Maniagar who has had an agricultural training and was till recently an officer of this Society, the agricultural possibilities of Delft will be steadily extended with such assistance as this Society will be always ready to afford him in the elaboration of any practical schemes calculated to develop the resources of the Island.

C. DRIEBERG,
Secretary, Ceylon Agricultural Society.

6th June, 1916.

AGRICULTURAL IMPROVEMENT IN HEADMEN'S DIVISIONS.

(Paper read before the Annual Meeting of the Ceylon Agricultural Society, June 6th.)

When Sir Henry Blake in 1904 founded the Ceylon Agricultural Society and signified his personal interest in its welfare, the chief headmen of the districts vied with each other in promoting the objects of the Society. Among these were Gate Mudaliyar WICKREMARATNE, late of Weligam Korale, and MAHAWALATENNE RATEMAHATMAYA of Balangoda, who as members of the Board read papers embodying the results of their work in their own particular districts. Both these officers did excellent work for the Society by establishing branch Agricultural Associations, organising shows and competitions, opening experimental gardens, and in many other ways.

My duties first as an Agricultural Instructor and later as Secretary to the Board of Control, Co-operative Credit Societies, have brought me into close contact with the chief headmen of the Island, and I have been thinking that a few notes embodying my experience of what improvements a headman interested in his division could effect, by referring to a concrete case, may suggest to other chief headmen ways and means of doing similar good work.

My first visit to the Kalutara District was in 1907 (when the late MR. J. CONROY whose loss we deplore was Assistant Government Agent) in connection with a paddy transplanting experiment under the supervision of the then Totamune Mudaliyar, MR. J. V. G. JAYAWARDENE, J. P. Since then I have been in touch with the District, attending village shows, conducting ploughing demonstrations and more recently organising Co-operative Credit Societies.

MR. CONROY's successor, MR. G. F. PLANT, took the greatest interest in all questions pertaining to education and agriculture and it was no doubt he who fired the enthusiasm of MR. J. A. WIRASINHE, Mudaliyar of Rayigam Korale. This Korale is one of the largest chief headmen's divisions in the district with an area of 83,200 acres and a population according to the last Census, of 591,889. The extent under Paddy is 13,130 acres, Rubber 11,570, Tea 5,722 and Coconut 19,210. There are also Cinnamon and other low-country products, while vegetables are cultivated on an extensive scale.

A beginning in the improvement of village agriculture was made by the starting of a branch agricultural association in 1907, the members contributing to form a fund for establishing an experimental garden, any balance left over being devoted to procuring copies of the GOVIKAM SANGARAWA the Sinhalese magazine of the Agricultural Society, to be supplied to members

In the year 1907 the garden was opened with a grant from the Parent Society equal to the sum locally raised, in accordance with the principle that help is only given to those who help themselves. The garden is over 5 acres in extent, occupying a central situation (Bandaragama). It is mainly devoted to fruit culture, but contains other economic products, green manure plots and nurseries for the distribution of plants. The collection of fruit trees is large and representative and includes several grafted plants introduced from abroad. To make the place both attractive and useful an ornamental garden and a circuit bungalow were provided, the cost of the latter being met from the Gansabawa funds.

Four village shows held in the district for a number of years gave a great impetus to the cultivation of fruits and vegetables. A feature of these shows was the distribution of money prizes for the best kept compound in each village with a view to the improvement of rural sanitation. They were also made the occasion for the presentation of a shield for the best school garden of the year.

The latest phase of agricultural work in the Korale is the institution of Co-operative Credit Societies of which there are four. These societies help the cultivator financially to carry out improvements in his cultivation. The four societies are situated in convenient centres, viz., Wewita, Horana, Galapatha and Handapangoda. They have 455 members and the paid up capital is Rs. 4,093. Loans are made for various agricultural and industrial purposes. Meetings are held regularly and are presided over by the Mudaliyar, who has the co-operation of his headmen and others who have volunteered to work for the cause. The services of four teachers of village schools have been engaged as honorary secretaries, and the treasurers are men of good status. The committees are made up of the most intelligent headmen and prominent men in the village. Hitherto the villagers purchased their bone-manure for paddy from village boutique-keepers without any guarantee of its purity. Since 1915 the four societies have distributed among the members not less than forty tons of pure bone-manure purchased at moderate cost. One of these societies has just obtained a loan of Rs. 1,000 on interest at 4½ per cent. per annum repayable within 10 years in annual instalments. These societies should go a great way to release the masses from the thraldom of the usurer, inculcate the principle of thrift and self-help, and put a stop to reckless borrowing which has been the ruin of the cultivator. Apart from the material benefit there are also moral and social advantages enjoyed by the people.

In effecting all this the chief headman has been of invaluable service, and without his influence and willing help the task would have been a hopeless one. SIR ROBERT CHALMERS said at the Co-operative Credit Conference held in 1914, "I remind the Chiefs and Headmen that they are given rank and position, not for their own benefit, but in order that their influence for good may shine forth among those with whom their lot is cast. I will only add here that good services rendered in the formation and effective working of Co-operative Credit Societies will not go unnoticed by Government when occasion arises to appraise merit and recognise good work done for the public welfare. . . . . ." "I should like to conclude with a few words of recognition of those to whom is due the credit of such success as has been hitherto achieved. I begin with the Chiefs and Headmen, because, being leaders of the people they were naturally appealed to for assistance. In most cases the appeal has been answered loyally and generously, and they have laudably identified themselves with the success of village societies."

In conclusion I would urge the chief headmen of the Island—whether of the low-country, Kandyan or Tamil districts—to do all in their power to bring within the reach of the rural population in their divisions the benefits which the Agricultural Society and Co-operative Credit Societies have to offer them, and thus emulate the excellent example which the Mudaliyar of Rayigam Korale has set.

N. WICKRAMARATNE,

6th June, 1916.

Secy. to the Board of Control,
Co-operative Credit Societies.

POULTRY.

COMMON DISEASES OF POULTRY.

B. F. KAUPP.

This Bulletin (Bull. No. 233, North Carolina Agric. Expt. Stn.) has been compiled by the Director of the Laboratory for Poultry Investigations and Pathology, Animal Industry Division, North Carolina Experiment Station, West Raleigh, and is especially intended for practical poultry keepers. The treatments recommended are the result of the writer's experience.

Against poultry lice (*Menopon biseriatum* and *M. pallidum* on chickens; *Gonoides stylifer* on turkeys; *Lipeurus baculus* on pigeons) a very effective insect powder is made by taking crude carbolic acid one pint, and gasoline three pints, mixing with sufficient plaster of Paris to make a slightly moist mixture, then rubbing it through a sieve. Let it lie for about two hours when the powder will be found to be dry. If not used at once it must be kept in a well closed can. A bird thoroughly dusted with this mixture need not be redusted for three months.

Against the large head louse (*M. biseriatum*), a good treatment is to grease the tops of the head with plain vaseline or lard if the chicks are young, while older birds are best treated by either dipping in a good coal tar dip or by dusting with an insecticide.

Against mites, cleanliness, disinfection and dusting with the insect powder mentioned above are recommended.

Against scaly legs, soak the scabs with warm water; then with a brush remove all scabs possible, after which scrape with a dull knife. When the legs are dry, saturate with gasoline. Repeat this treatment every five days. A hot solution of lime and sulphur dip has been used with excellent results.

Internal parasites:—

The large round worm (*Ascaris inflexa*) is present in over 25 per cent. of the birds purchased on the market. As a preventive measure the yard and fowl house must be kept clean. As treatment the birds should be made to fast for 24 hours, then give each bird one teaspoonful of olive oil and one teaspoonful of turpentine separately.

The tape worm is treated by fasting the birds 24 hours and then giving them a teaspoonful of turpentine and a tablespoonful of Epsom salts dissolved in hot water. If it is desired to avoid medicating each bird separately, give three grains of powdered arecanut to each bird in a mash made of wheat sorts.

The gape worm forms clusters in the trachea of many birds and it is treated by extirpating them by means of a doubled horse hair or by a feather dipped into turpentine.*

Contagious diseases.—Black head or *enterohepatitis* affects turkeys and more rarely chickens. For its treatment permanganate of potash may be

*CH. VOISELLIER (*Aviculture*, Enc. Agric. Paris, Bailliere, 1909, p. 425) states that 95 per cent. of the cases can be cured by subjecting the affected birds to fumigations of sulphurous acid or carbolic acid.

used in the water. Sulphocarbolates of calcium, sodium and zinc in equal parts have given good results in doses of half a grain of the mixture three times a day for each bird.

Fowl cholera.—Intestinal antiseptics are indicated. Permanganate of potash can be used as recommended under black head. Also the three sulphocarbolates are valuable, as well as a solution of one part of bichloride of mercury in ten thousand of water.

White diarrhœa caused by *Bacterium pullorum* has been successfully controlled by the sulphocarbolates mentioned above.

Chicken-pox or sore head may be treated by touching the sores with carbolic acid or with iodine or kerosene. Sick birds should also be given a tablespoonful of castor oil.

Roup or *avian diphtheria* is a highly contagious disease, and if the bird affected with it is not a valuable one it is better to destroy it. If it is desired to treat it the nasal canal must first be syringed with a 20 per cent. solution of bicarbonate of soda to dissolve the mucus, then with equal parts of peroxide of hydrogen and water so as to cleanse thoroughly the parts, after which the following mixture should be injected:

Oil of thyme 30 minims, oil of eucalyptus 20 minims, menthol 10 grains, oil petrol 2 ounces. All these liquids should be warm. The ulcers in the mouth are to be touched with a stick or nitrate of silver.—BULL. INT. INST. OF AGRIC.

EXPORTS OF CEYLON PRODUCE.

The large increase (142,700 lb.) in the exports of cardamoms is extraordinary in view of the diminished demand and the difficulty of selling any but the higher grades at a profit. The spice has already suffered by the war, and we look for diminished exports in 1916, as the tendency is to reduce the planting area. Citronella oil shows a revival, being 249,640 lb. more compared with 1914, which was a poor year. The exports of cinnamon were as follows (lb.):

		Quills.	Chips.	Total.
1914	...	2,361,994	1,498,464	3,860,458
1915	...	4,123,433	2,045,287	6,168,720

The above figures show the remarkable increase of 2,308,262 lb. of quills and chips, which is well distributed among the importing countries, the U.S.A. being the largest consumer of quills (1,416,965 lb.), the United Kingdom receiving 1,333,123 lb.; but of chips the U.S.A. received only 57,828 lb., against the 1,280,870 lb. for the United Kingdom. Spain was a large consumer, with 951,589 lb. of quills and 213,860 lb. of chips. Coconut-oil shipments were well maintained, but copra declined, the United Kingdom imports dropping by over 22,000 tons in 1915. Both Denmark and Holland took increased quantities, and up to the close of the first quarter of 1915, there is every reason to believe, the bulk of these non-contraband goods went through to Germany, but this business practically ceased with the formation of the Netherlands Overseas Trust.—CHEMIST AND DRUGGIST.

CO-OPERATION.

THE CO-OPERATIVE MOVEMENT.

VLADIMIR SAVITZKY.

This year marks the beginning of the second half-century since the foundation of the first Co-operative Association in Russia.

Russian co-operation saw the light during an epoch of great reform—the emancipation of the serfs, the introduction of the Zemstvos, and the reorganisation of the judiciary. Following the first Loan and Savings Association established in Kostroma province by the brothers LUGININ, the local landlords, the first societies of consumers arose in Riga and Tomsk. In other northern provinces several cheese dairy associations speedily followed. From these nuclei grew that mighty popular force which Russian co-operation represents to-day.

In 1895 a new type of credit co-operative organisation—"Credit Association"—was created, in which the place of share capital is taken by a loan from the State Bank or local Zemstvo. Loan-savings (share) Associations are diffused principally in those regions of Russia where the population is more well to do; while credit associations predominate in the poorer eastern provinces. A distinctive trait of Russian consumers' societies is that they not only provide the peasantry with necessary commodities, but also organise the sale of various products manufactured by the peasantry. Since 1905 the co-operative movement has been a popular one. In the towns not individual intelligent groups, but the residents themselves—officials, workmen, clerks, etc.—have entered upon the organization of consumers' societies. In the villages not merely the teacher or the landlord, but the people themselves are everywhere organising their labour associations. Since 1905 the co-operative movement has developed with gigantic strides. The total of this development in quinquennial periods is shown below:—

	Number of Consumers' Societies.	No. of Credit, and Loan and Savings Associations.
1865	2	—
1870	73	11
1875	92	514
1880	117	995
1885	175	1,189
1890	260	1,276
1895	482	1,330
1900	897	1,500
1905	1,804	1,620
1910	6,799	6,679

For the quinquennial period 1905-10 the co-operative movement made an advance five times as great as that for the entire preceding 35 years. A vivid

idea of the growth of co-operative societies is afforded by the following comparative data:—

—		On Jan. 1, 1910	On Jan. 1, 1912
Small agricultural societies	...	137	2,345
Butter Unions (*artel*) in Burma	...	51	1,554*
Loan and Savings Association	...	743	2,561
Credit Associations	...	94	5,523
Consumers' Societies	...	600	6,100
Total		1,625	18,083

THE FIRST UNION.

For the decade the number of associations increased more than ten times. Concurrently with this quantitative growth of the co-operative movement both the internal organization and co-operative consciousness of these institutions are developing. The co-operative bodies of various types unite round them all the more enterprising, cultured, and sensible elements of the population. In 1901 the first union of credit co-operative societies arose in Berdiansk, and in 1911 five of such unions, embracing 98 associations, were counted. At the same time, the unions received permission to accept deposits and issue loans, while at Moscow the People's Bank was founded—a central organization of co-operative credit institutions which counts among its shareholders nearly 1,500 co-operative associations. In 1914 the turnover of this bank reached 110,000,000 roubles (£11,610,000). Incidentally, it has organised the sale of eggs and flax abroad. Just as this bank constitutes an amalgamating organization for credit co-operations, so the Moscow Union of Consumers' Societies, with a turnover of 10,000,000 roubles (£1,050,000) annually, serves as a similar centre for consumers' co-operative bodies.

The Yekaterinburg Union of Credit and Loan and Savings Associations furnishes an interesting example of the growth of co-operative amalgamation. The union is still a young institution. Commencing its activity in 1906 with a complement of only sixteen associations, and possessing considerable means, the Union has gradually grown into a powerful organization now consisting of seventy-five associations. The turnover of the Union, which in 1907 amounted to 43,436 roubles (£4,500), in 1914 had attained the sum of 4,517,456 roubles (£476,000). At Yekaterinburg there has been built at the expense of the Union a co-operative palace, thoroughly up to date, with premises for shops, warehouses and printing offices. The Union is deservedly the pride of the co-operative bodies of the Urals.

SIBERIAN ASSOCIATIONS.

The above-mentioned butter co-operations in 1908 formed the Siberian Union of Butter Artels, which now comprises 330 separate organizations, with a turnover of 15,000,000 roubles annually (£1,570,000). More than half the quantity of Siberian butter is manufactured by co-operative butter associations.

Besides the chief office at Kurgan, offices of the Union have been opened in a number of Siberian towns. Inasmuch as the Union sells butter principally in England, it has a permanent bureau in London. A considerable improvement of technical appliances has assisted the development of the co-operative butter business, and Siberian butter has now taken a lasting

* About.

place on the world's markets. Less important unions of dairy associations sprang up at Riga, Yuriev Vologda, Petrograd, and Moscow.

In other branches of agriculture are diffused co-operative associations for the acquisition of agricultural instruments and machinery. Attempts are also being made to organise the sale of fruit, dried vegetables, and eggs upon co-operative principles, while the organization of potato factories by the societies is proceeding fairly successfully. In the south several co-operative flour mills have been built, and in other places elevators for grain products.

OTHER SOCIETIES.

Concurrently with the above-mentioned butter co-operative associations in Siberia, several organizations of this kind in the north of European Russia are of interest for England, for example the Union of Tar-works Artels of Archangel province, through which is carried on the sale of tar manufactured by the local peasantry. Moreover, the Union has organised eleven factories for the production of resin and turpentine. This organization, like many others, disposes of large resources, and possesses its own houses, warehouses, river steamers, barges, etc.

Of recent years the growth of the co-operative movement has proceeded exceptionally rapidly; co-operation is ever more widely and deeply penetrating into the economic life of the country, and ever new types of co-operative societies are springing up. It is interesting to note the formation of such societies among the Ostiaks in the depths of the Narym region, among the Karanagaits of the Terek province—the inhabitants of which are only just beginning to pass from a nomadic to a stationary form of life—and among the Bouriats of the Trans-Baikal province.

How widely co-operation has taken hold upon the masses themselves can best be attested by a series of individual examples depicting the significance of co-operation in the life of some region or other of illimitable Russia. In the Kostroma province, for example, rural co-operation embraces 33 per cent. of all householders of the province. In Yaroslav province the percentage of householders united through co-operative organization has already risen to 50, while in Tula province it amounts to 65.

STATISTICS.

In absolute numbers the significance of co-operation for individual regions is shown as follows:—In Orel province, for example, co-operation embraces 244,000 persons, in Tambov 293,620, and in the region of the Don Cossacks, 350,000.

In Russia at the present time there is a total of more than 35,000 co-operative societies, and according to numbers Russia will soon occupy first place in this movement. Already in membership, which is close upon 12,000,000 she has overtaken all western countries. Reckoning an average family, whose head is a member of society, at from four to five persons, we find that the number of inhabitants interested in co-operation amounts to between 40 and 50 millions—i.e., about one-third of the population. But independently of the number of members, Russian co-operation, judged by its economic turnover, is impressive. The turnover of loan and savings and credit associations on July 1st, 1914, amounted to 773,162,600 roubles (£81,600,000), while the associations had capital of their own amounting to 96,000,000 roubles (£10,130,000), Governmental resources amounting to 48,000,000 roubles

(£5,060,000), and other funds placed at their disposal amounting to 48,700,000 roubles (£5,140,000).

The budget of all the co-operations of Russia totals many milliards of roubles—i.e., exceeds the budget of all Russian towns, Zemstvos, and industrial organisations, and is less only than the State Budget.

The Moscow People's Bank, ever increasing its turnover, is becoming the recognised all-Russia centre in the business of purchasing articles of productive consumption and the sale of agricultural products and articles of handicraft.

EFFECTS OF THE WAR.

The war has not disturbed Russian co-operation; on the contrary, it has given a fresh impetus towards further development, and in connection with the mobilization of the country the co-operations are serving the cause of the Imperial defence. They succour refugees, care for the families of Reservists, supply the population and the Army with food products, and purvey clothing and munitions for the Army. The common cause has strengthened the desire of the co-operations for closer union.

The co-operative association has now reached the village—the centre of all public life. Upon the association the Zemstvo relies in its undertakings; to the association the State appeals when it wishes to summon the people to the task of State defence; the association in the village is now the most energetic vehicle of cultural enterprises.

In the near future it is proposed to promulgate a new law in accordance with which will be established a simplified procedure for the creation of co-operative societies in place of the existing one, which is attended with numerous complicated formalities, and there is no doubt that then the co-operative movement will attain still wider scope.—THE TIMES RUSSIAN SUPPLEMENT.

A NEW HYBRID YELLOW WHEAT.

G. GAUDOT.

A new wheat, named "Ceres," has been obtained by crossing Yellow Briquet with Autumn Victoria in the experiment fields of MESSRS. DENAIFFE at Carignam. Having grown for some ten years under very variable conditions of soil and climate, it has always shown great constancy together with strong constitution; it is perfectly hardy and has remarkable rust resistance. This hybrid is, in nearly every point, clearly intermediate between its two parents; it is semi-late, tillers well, producing fairly long and firm straw, quite white when ripe.

Its characteristics are as follows: ears white, rather elongated, semi-compact, not tapering at the summit; spikelets arranged somewhat in the form of a fan with short, much inflated glumes, completely filled by the grain, which is medium-sized, short and very full, and bright yellow in colour.

This wheat, while giving a heavy crop of straw and grain, and extremely regular in its growth, is not exacting and suits all moderately fertile soils. The great strength of its straw also allows of its being grown on rich soils. Ceres seems from its pedigree and parentage to be likely to be one of the varieties that are really resistant to straw blight.—BULL. INT. INST. OF AGRIC.

GENERAL.

MR. H. F. MACMILLAN, F.L.S., F.R.H.S.

MR. HUGH FRASER MACMILLAN, who has left Ceylon on well-earned leave, completes this month 21 years in the Ceylon Government service.

During that time he filled the post of Curator of the Royal Botanic Gardens, Peradeniya, and has acted periodically as Superintendent of the Hakgala Gardens during the absence on leave of MR. WILLIAM NOCK (now retired), who will long be remembered in the Island for the excellent work he did in Nuwara Eliya and its environs.

With the re-organization of the Peradeniya Staff under the scheme for an Agricultural Department formulated by MR. R. N. LYNE, the Director of Agriculture, MR. MACMILLAN was appointed Superintendent of Botanic Gardens in Ceylon with a Curator to assist him at Peradeniya.

During his 21 years' service in the East MR. MACMILLAN has made a thorough study of the flora of the Eastern tropics in which he was aided by his knowledge of the Vernacular languages acquired soon after his arrival in the Island; and as the fruits of his experience he has produced his HANDBOOK OF TROPICAL GARDENING AND PLANTING which has become a standard work of reference.

A photographer of no mean order, MR. MACMILLAN's studies of plant life are in great request both for local and foreign publications.

In addition to his regular duties MR. MACMILLAN is lecturer on Economic Products at the School of Tropical Agriculture. He is the author of an excellent illustrated guide to the Peradeniya Gardens, and has written numerous bulletins for the Department of Agriculture, papers for the Agricultural Society and articles for the TROPICAL AGRICULTURIST.

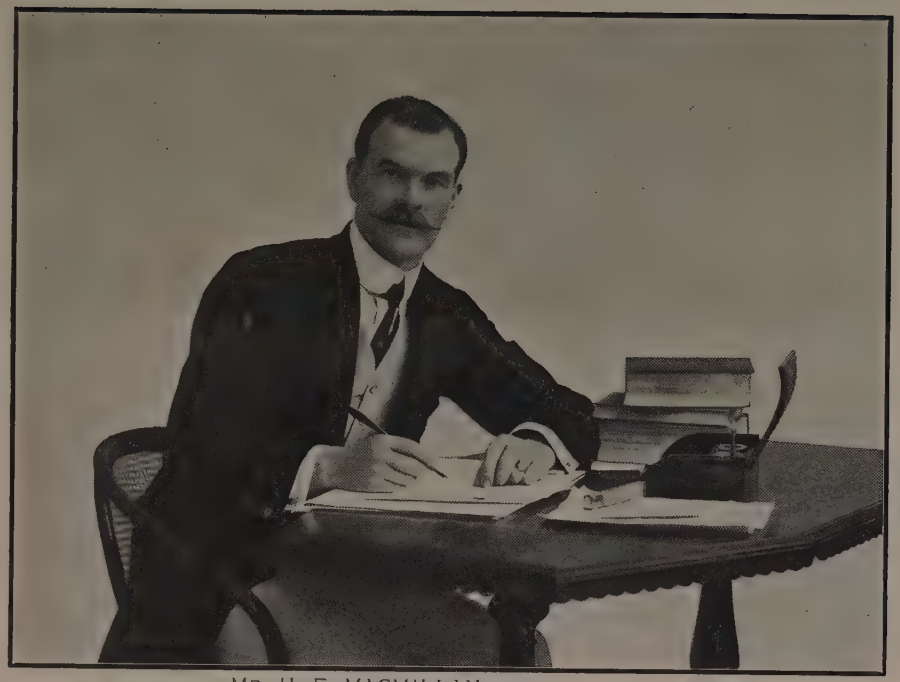
The Peradeniya Gardens of to-day owe much of their beauty and attraction to his trained and artistic eye which has also brought him into prominence at our Agricultural Shows.

We take this opportunity of wishing MR. MACMILLAN a safe voyage to and from England.

THE ARBORETUM AT PERADENIYA.

The well-known Botanic Gardens at Peradeniya provide a most favourable locality for the representation of the principal tropical plants, having regard to the striking differences of the climate and distribution of rainfall prevalent in Ceylon. Situated at an elevation of 1550 ft. above sea level, an average temperature of 76 deg. and an average rainfall of 88 inches well distributed throughout the year, it is possible to establish with a fair degree of success practically all representatives of the wet tropical and intermediate regions, but the purely equatorial species demand a lower elevation and a warmer climate.

The Arboretum, situated at the north end of the Gardens, comprise some 48 acres, in which a representative collection of trees and shrubs of Ceylon and other tropical regions has been brought together and grouped in their respective natural orders, the planting and nomenclature following as closely as possible the lines of BENTHAM and HOOKER'S *Genera Plantarum*. The best



MR. H. F. MACMILLAN, F.L.S., F.R.H.S.,
Supdt. of Botanic Gardens, Dept. of Agriculture, Ceylon.

flowering and ornamental species of the respective orders have been planted near the River Drives to add as far as possible to the attractions of the Gardens to the visitor.

Two vistas, originally opened in 1898, traverse the arboretum in different directions, one opening up the magnificent view of the slopes and peak of Hantane (4,117 ft), and the other commanding a fine view of Gangoruwa hill. These at the same time have the additional advantage of facilitating inspection of the collections.

The arboretum is labelled throughout with brick labels, the top half of one side of the brick being sloped and smoothed, and the letters printed in white, on a black background. These have the advantage of being cheap and proof against attacks by white ants, etc., but require renovating about every two years or so. The more permanent method of lead labels as adopted at Kew would be a great advantage here, but is impracticable owing to the pilfering habits of coolies.

In the notes that follow reference is made to the more important specimens (with special reference to the more recent introductions) to be found in the arboretum, with short descriptions and as much information as should make them more interesting to the student as well as to the casual visitor.

1. *Monodora tenuifolia* (Anonaceæ): A beautiful flowering tree of tropical Africa, introduced into Peradeniya in 1897 from Kew, 20 to 30 ft. high, bearing large flowers 2 to 4 in. across, outer petals pearly or greenish white, marked with deep red. Flowers here in April at stage of young growth.

2. *Pangium edule* (Bixaceæ): Native of the Malay Archipelago where it is known as "Pangi," introduced into Peradeniya in 1891 from Java. A very large tree with immense heart-shaped leaves, yielding a hard solid wood.

The seeds contain hydrocyanic acid, but can be eaten after long soaking to dissipate this.

3. *Shorea selanica* (Dipterocarpaceæ): A large tree, native of the Moluccas, which yields a strong and valuable timber. A good specimen of this tree can be seen on the left of the Peradeniya Gardens entrance gate, measuring nearly 100 ft. in height and unbranched for 45 ft.

4. *Kokia Rockii* (Malvaceæ): introduced into Peradeniya from U.S. Department of Agriculture in 1913, and reported to be a beautiful tree of Hawaii, where it has become almost extinct. It is also stated that there are only three living specimens of this tree in existence.

5. *Ochroma Lagopus* (Malvaceæ) A large tree, native of the W. Indies and Tropical America, and known as the "Cork" or "Wool tree," introduced into Peradeniya in 1884.

Quite a useful tree for shade or ornament, bearing long, brown woolly fruits. The wood is very light, spongy and soft, and is used for floats, canoes, etc. The seeds are embedded in wool, the latter being used for stuffing pillows and cushions.

6. *Sterculia acerifolia* (Sterculiaceæ): Native of S. Australia and commonly known as the "Flame Tree," owing to its bearing large masses of brilliant red flowers, introduced into Peradeniya in 1882. Thrives better at higher elevations. Flowers here in February.

7. *Luehea speciosa* (Tiliaceæ): A small tree native of Brazil and introduced into Peradeniya in 1909 from Kew. Of semi-scandent habit and very handsome when in flower. The wood is white, very light, but close grained, and is used to a great extent in Brazil for musket stocks and wooden shoes. The bark of other species of this genus is used for tanning purposes.

8. *Balanites Manghamii* (Simaıubaceæ): An oil-producing tree of the dry regions of Portuguese East Africa and introduced into Peradeniya in 1914

from Kew. A tree attaining a height of 45 to 60 ft., of forbidding aspect, bearing large thorns. Said to yield 40 to 50 lb. of seed annually from which 60 p.c. of fine oil is obtained suitable for lubricating and manufacturing purposes, and similar to the finest olive oil.

9. *Evodia elegans* (Rutaceæ): Native of New Guinea. An ornamental tree or shrub, introduced into Peradeniya in 1900, and bearing pretty snow white flowers. Used as a hedge plant, and proves very useful and ornamental as such.

10. *Casimiroa edulis* (Rutaceæ): A small tree of Central America, introduced into Peradeniya in 1899 from California. The tree is cultivated in Mexico for the fruit which is edible and has an agreeable taste, but is said to induce sleep and to be unwholesome. The seeds are poisonous and the bark bitter. The bark, leaves and seeds when burnt are used medicinally in Mexico.

11. *Quassia Amara* (Simarubaceæ): "Surunam Quassia." A shrub native of Guinea introduced here about 1853. The original Quassia of the Materia Medica and the one upon which the reputation of Quassia as a medicine was established. The bark wood has very bitter properties.

12. *Cedrela odorata* (Meliaceæ): "West Indian Cedar," a well known tree of the West Indies and Mexico, introduced into Peradeniya in 1884. Yields a valuable light wood which is considered the best for cigar boxes, as it cuts freely, is durable, and has a pleasant smell.

13. *Sapindus saponaria* (Sapindaceæ): The Soap-berry Tree. Native of tropical America and West Indies, and introduced into Peradeniya in 1881. A small tree, the berries of which, containing Saponin, form a lather in water, and are sometimes used as a substitute for soap. The black seeds are sometimes polished and used for making necklaces.

14. *Harpullia pendula* (Sapindaceæ): "Tulip wood of Australia." A moderate sized tree of Queensland, yields a valuable timber, strong and durable, and is used in Australia for all kinds of cabinet-work. Introduced into Peradeniya in 1883.

15. *Sclerocarya caffra* (Anacardiaceæ): A handsome tree, bearing large coriaceous leaves, native of South Africa, where it is known under the name of "Morula," and introduced into Peradeniya in 1901. The seeds are edible. Grows well at Peradeniya, but has not yet flowered.

16. *Erythrophlœum guineense* (Leguminosæ): Known as the "sassy bark" of Sierra Leone, native of West Tropical Africa, and introduced here in 1902. A large tree attaining a height of 60 to 100 ft. The bark yields a powerful poison, used as an ordeal, and the red juice obtained from the tree is also used for its poisonous properties.

17. *Brya Ebenus* (Leguminosæ): "Jamaica Ebony." A small tree native of Jamaica and Cuba, and yields a good timber. The heartwood turns black with age as with the true Ebony, and takes a beautiful polish. The "Cocus wood" used for flutes, etc., is supposed to be produced by this tree.

18. *Pithecolobium unguis-cati* (Leguminosæ): A large shrub or small tree of Tropical America and West Indies, and introduced into Peradeniya in 1908.

The bark has astringent properties, and is used considerably in native medicine. It is also used as a hedge plant in the West Indies, being kept clipped to a height of about 5 ft. and is most effective, proving a good barrier as such.

19. *Diplerix odorata* (Leguminosæ): "Tonquin" or "Tonga Bean." Native of Tropical America and introduced into Peradeniya in 1881. Grows to a great size, and yields a most valuable timber. The fruit is one seeded, these being the Tonga beans of commerce used in perfumery, snuff, etc. The

flowers are very fragrant and are used by perfumers. The tree grows well at Peradeniya, but has not yet seeded.

20. *Dimorphadura Mora* (Leguminosæ): "Mora." A large tree, native of British Guiana and introduced into Peradeniya in 1881. An excellent timber obtained, being hard and durable, is used for cabinet work. The tree attains a height of 100 to 150 ft., and is often unbranched for half the height, and bears exceptionally large seeds.

21. *Baikea insignis* (Leguminosæ): A medium sized tree, native of West Tropical Africa and introduced into Peradeniya in 1902 from Kew, 30 to 40 ft. high, bearing remarkably large white flowers about 6 in. or more in diameter. Flowered here in 1913 for first time, and again in 1915, but has not yet fruited.

22. *Gustavia insignis* (Myrtaceæ): Native of Colombia and introduced to Peradeniya in 1884. A small tree, much branched, possessing great beauty both in foliage and in flower, the latter being nearly 5 in. in diameter, with cream white petals, at tips a rose colour, numerous stamens with filaments rose colour towards apex and anthers orange colour. A remarkably pretty tree. Flowered at Peradeniya in 1901 and again in 1915.

23. *Bertholletia excelsa* (Myrtaceæ): "Brazil Nut." Native of Guiana and introduced to Peradeniya in 1880 from Kew. A large handsome tree, common on the banks of the Amazon and yields the Brazil nut of commerce. Bears large, handsome leaves 16 to 20 in. long, and large hard-shelled fruits, 6 in. or more in diameter, each fruit containing 12 to 20 seeds. The tree takes about 14 months to ripen its fruits, and the seeds take about 9 to 10 months to germinate from time of sowing. The tree at Peradeniya fruited for the first time in 1900, and in 1915 produced 51 fruits.

24. *Clavija ornata* (Myrsinæ): A small and very pretty tree of South America, bearing a crown of leaves of large size and of palm-like habit varying from 18 to 20 in. long, and producing racemes of bright orange coloured waxy flowers which are borne on the axils of the leaves, from the scars of fallen leaves, or on the bare trunk. The root of this tree is sometimes used as an emetic.

25. *Mimusops Kauki* (Sapotaceæ): Native of Burma, Malaya, and introduced into Peradeniya in 1901. A small tree, similar to *M. hexandra*, bearing brownish purple berries, the fruits of which are of an agreeable acid flavour, and used mixed with the roots of Ginger as a cataplasm for tumours.

26. *Cerbera Tanghin* (Apocynaceæ): A small tree, native of Madagascar, the fruits of which contain a poisonous juice used in Madagascar as an ordeal in cases of suspected crime. The fruit is about the size of an almond and is said to be sufficient to poison 20 persons.

27. *Holarrhena antidysenterica* (Apocynaceæ): A small tree of Tropical Asia, known as "Kurchi" or "Conessi bark." The wood is used largely for turnery and furniture. The bark and seeds are bitter and used a great deal in Hindoo medicine, the bark being one of the principal remedies for dysentery. The flowers are white and sweet scented.

28. *Acokanthera spectabilis* (Apocynaceæ): "Arrow Poison." Native of South Africa. A large shrub or small tree bearing masses of white fragrant flowers. The seeds are intensely bitter and the whole plant is considered by the natives of Africa to be deadly poisonous, the root being used for poisoning their arrows.

29. *Arthrophyllum (Phyllarthron) Bojerianum* (Bignoniaceæ): Native of Madagascar and introduced here in 1902. A shrub of peculiar appearance, and rare. The leaves are reduced to winged petioles which are biarticulate, the upper ones elliptical, more or less acute, and the lower ones narrow, cuneate, subcoriaceous, glabrous. The fruits are edible.

30. *Aegiphila martinicensis* (Verbenaceæ): A handsome shrub, native of the Martinique Islands, and introduced into Peradeniya in 1908 from British Guiana. Very similar to Rondeletia, and bears clusters of bright pink flowers. Most useful for ornamental purposes.

31. *Persea Nammu* (Lauraceæ): A small tree native of China and introduced here in 1884. The source of Nammu wood, the latter being extremely hard and durable, and used in China to a large extent for buildings, bridges, furniture, etc.

32. *Cinnamomum Cassia* (Lauraceæ): "Cassia Bark." A medium sized tree, native of Burma and China, and introduced into Peradeniya in 1882; yields the well-known "Cassia buds" used as a spice, chiefly in confectionery.

The bark is often used to adulterate cinnamon. The tree grows fairly well at Peradeniya, but rarely produces seed, and is very difficult to propagate.

33. *Brosimum Aubletii* (Urticaceæ): "Leopard" or "Snake wood." A good timber tree of Peru and Brazil, growing to a height of 60 to 70 ft. The heartwood is extremely hard and well mottled with dark blotches, having a fancied resemblance to the skin of a tiger or snake.

T. H. PARSONS.

AGRICULTURAL RESEARCH IN INDIA.

The report of the Agricultural Research Institute and College, Pusa, for 1914-15 has come to hand and comprises the reports of the Director, Imperial Agriculturist, Agricultural Chemist, Economic Botanists, Mycologist, Entomologist, Pathological Entomologist, Agricultural Bacteriologist, and Cotton Specialist.

The report of the Agricultural Bacteriologist is a valuable one indicating much research work on the subject of bacterio-toxins in soils.

In soils in which æration is incomplete, as a consequence either of want of proper cultivation or of drainage, the decomposition of organic matter by such bacteria as thrive under these conditions will result in the production of toxins inhibitory of nitrification. It has also been shown that these toxins are destroyed by exposure to air and can be removed in water solution, so that the ordinary operations of tillage and drainage can prevent their accumulation.

Work with seedlings has shown that in high concentration, such as occurs in water-logged soils containing much organic matter, these toxins may directly affect growing plants especially seedlings, but this is an exceptional condition, whereas it appears probable that in normal fully ærated soils the toxins resulting from the ordinary metabolic activity of soil bacteria are oxidized at about the same rate as they are produced and no accumulation takes place. A very slight interference with the oxygen supply to the soil, however, will turn the scale in favour of accumulation of toxins and in consequence upset the natural equilibrium existing in the soil complex between the toxin-sensitive nitrifying organisms on the one hand and the apparently less easily affected reducing organisms on the other, thus resulting in indirect injury to the crop by interference with the supply of nitrogen as nitrate. In soil which has been flooded during the monsoon the toxins formed may persist long enough to seriously prejudice the growth of seedlings if planted too soon; such soil should be given as long a period of æration as is possible before planting.

It was found in the case of seedling maize and sorghum grown in soil or sand and watered with extracts of soil made toxic by keeping the latter under semi-anærobic conditions that the residual contents of the seed were

attacked by bacteria which had multiplied as a consequence of the prevalence of such conditions and had been transferred with the toxic extracts; the result of this attack was the production of toxic putrefactive bodies in immediate contact with the seedling resulting in its death; this did not occur in presence of copper sulphate. MR. MILLIGAN, Imperial Agriculturist, who drew my attention to the above-mentioned field result with copper sulphate, has pointed out the significance of this observation in connection with this case, and the importance of its bearing upon the vital question of successfully bringing a field crop through the initial stages of germination and growth especially in heavy soils. Experiments are being carried out to test the value of antiseptics in relation to the early stages of plant growth under varying soil conditions from this point of view.

TRAINING MEN TO CONDUCT RESEARCH.

PROFESSOR J. A. FLEMING, F.R.S.

Whilst the highest achievements in scientific research and invention must always depend to a great extent on that indefinable quality we call genius which cannot be made to order, it can scarcely be doubted that much can be done to foster and assist it.

The nation must be educated to see that the men with high scientific and inventive ability in it, not by any means too numerous, constitute a national asset of inexpressible value. This power, when it exists, should not be allowed to dissipate itself in a struggle to secure the means of living, but be given an opportunity for the fullest exercise and use. There can also be no question that we have it in our power by suitable methods of education to develop such nascent ability.

Our present systems of education, and particularly the system of written examinations which are dependent so much on good memory for success, do much to destroy originality. In spite of all that has been written and said on this subject, we do not seem to be nearer to essential reforms. The object of all education is threefold: first to train character, will, and that power of selecting the best amongst various courses of action which we call right judgment; secondly, to impart necessary information and ability to do certain things well; thirdly, to develop initiative and the power of handling new problems or investigations and a certain alertness in dealing with new situations. Our present methods of education are far too much directed to supplying ready-made and peptonised information.

The great outstanding fact in modern life is the degree to which the energies and materials of nature are employed to overcome the difficulties created by the increase and concentration of population. We have to make the earth bring forth her increase at a greater rate, to supply the ever-increasing necessities of growing populations and the many artificial wants which have been created by progressive human desires. Hence an absolutely essential part of any complete education is some knowledge of science, and especially of its influence on the welfare of mankind. Yet the people we put in a position of authority over us are, for the most part, not only ignorant of science, but not even interested in it. In our public schools we train boys chiefly by directing their attention towards the form of the grammar and literature of two dead languages, and we neglect to give them any wide and sufficient knowledge of things—viz., the physical phenomena of the universe in which they live.

Is it, then, any wonder that when these boys grow up and take their places in Government offices, in the Law Courts or on the Press, or any other influential position, they are oblivious to the last degree of events

taking place in the world of science which have in them the power to make or destroy national industries or affect the living of large populations? The destruction of the madder industry of France and the indigo industry of India by German synthetic chemistry are not old and familiar stories.

The point, however, to notice is that the scientific chemical discoveries were not allowed to remain mere laboratory feats. They were transformed into successful commercial enterprises. The BADISCHE ANILIN UND SODA FABRIK is said to have expended £1,000,000 and taken seventeen years work in translating BAEYER'S scientific synthesis of indigo into a factory process. But the result has justified the foresight of those who expended it. This is only one instance out of many which could be quoted to show the blows that can be inflicted in this industrial warfare, the weapons in which are not shot and shell, but scientific discoveries and inventions.

The supremely important question is: What are the steps we are taking to train the men who will enable us to hold our own in this commercial conflict? It avails nothing to point out that the beginnings of many of these achievements were laid by British scientific discoveries or original suggestions. A truth or a suggestion which is not followed out or pressed to the point at which it becomes practically productive is like a seed which is not planted in the ground. The intellectual perception of a truth or principle requires behind it the driving force of character and will if it is to pass into the useful stage.

Some people might be inclined to ask why there should be this competition and pressure to invent? What difference does it make who discovers a new fact or makes a new application? If scientific knowledge were a mere matter of intellectual curiosity concerning the secrets of nature it would not matter much, except for national honour, who made the discoveries or applications. But scientific knowledge has become much more than this. It has become the means of increasing national wealth, and also by which national wealth can be taken away. Again, in virtue of our patent laws, it has become possible for alien inventors to prevent us from even using in our own country in particular ways the waste products of our own industries as in the case of certain coal-tar products. Hence scientific knowledge can be applied so as to become a tremendous weapon of destruction as well as of national strength. It is for this reason that we require men to be trained, not merely to make scientific discoveries, but to make useful commercial applications of them, which are wealth-producing or wealth-conserving in a national sense. This requires a peculiar combination of scientific ability and commercial insight, and it is just here that Germany has the advantage.

MR. LLOYD GEORGE said on one occasion that he feared Germany's war-bred spirit, by which he meant the willing subjection of a whole empire to discipline. We might say, with even more truth, that what is to be feared is Germany's militant chemistry and engineering, or that combination of commercialised science which is relentlessly applied to undermine and take away sources of power of other nations. This, however, is what we have to meet. We have to train chemists, engineers, electricians, and physicists who are not only learned in the knowledge of their science and originative in discovering new facts and principles, but have also a keen commercial sense which directs them to the solution of the practically useful problems. We have, therefore, to create a very much closer union between industry and science. To some scientific men this seems derogatory to the dignity of science. On the other hand, men concerned with the business side of manufacture are apt to undervalue the aid which science can give them. Meanwhile, our scientific industries suffer from this dissociation.

In the first place we should aim at bringing about a much more intimate relation between the universities and technical colleges and the factories and workshops, so that the college teaching may result in producing a type of

man more useful in the factory. For this reason I am an advocate of the so-called sandwich system, by which the student spends a year alternately in the shop or factory and in the college, the first and third year being at the college and the second and fourth in the shop or factory. This turns out a better type of man than two years at the college and two years in the shop taken consecutively. It should apply not only to engineers in all branches but to chemists as well.

Then, again, conferences should be held from time to time between teachers and practical engineers and chemists for the exchange of ideas on the subject of the schemes of work and study to be followed by the student-apprentice, so as to turn out all-round men and not unpractical theorists or unscientific practists. We have to improve in many ways our college teaching, so as to expend to better advantage the available time, and place more stress on ability to use information than to store it. Engineering and chemical students should be brought much earlier than at present into contact with questions of cost and estimates, so that they may know not only how and why a certain machine works, but what it costs to make it, or to run it. They will then be far better able to take advantage of the workshop training and obtain earlier that "workshop sense" or instinct which looks at everything from the point of view of cost and profit, as well as operation or efficiency.

We have before us a tremendous task to restore the waste of this great war. To do this we have to utilise all waste products and to abolish waste and inefficiency in all departments of life, domestic, commercial, political, and industrial, and we have to get rid of them in scientific work as well. We can only do this by bringing to bear the scientific method upon all these regions of activity and even upon scientific research itself. As a small contribution to this work the above suggestions are tentatively put forward, and with the greatest diffidence I submit them now to your careful consideration.

—NATURE.

NOTES ON LIME-WASHES.

The following notes have been prepared by MR. J. C. F. FRYER, Entomologist to the Board, and MR. G. P. BERRY, General Inspector for Horticulture to the Board.

The insecticidal action of lime-wash when applied to fruit trees has always been a matter of controversy, and this is perhaps natural, for the washes in common use vary within wide limits, not only in their composition, but in the period and manner in which they are applied. The following notes deal only with certain aspects of the problem and are not intended as a discussion on the merits of lime washing in general.

Lime-washes in their simplest form are essentially cover-washes—that is to say, they imprison or impede the movements of insect pests which may be present on the sprayed trees. Frequently, however, their action is more complex owing to the addition of other substances which themselves may have some specific insecticidal action. There is then a difficulty in deciding whether good results are due to the mechanical action of the lime-wash or to the insecticidal powers of the substance added.

In this connection three cases of successful lime washing observed in 1915 are perhaps worthy of mention.

Case I.—A large orchard containing apples was lime-sprayed, while a second orchard, almost adjacent to the first and also containing apples, was left unsprayed. The sprayed orchard was treated with a wash containing 1 cwt. of quicklime to 60 gallons of water with the addition of a certain quantity of commercial lime-sulphur solution.

The work was carried out during April, and the latter applications were made on trees on which the blossom buds had separated and were about to burst. So late was the spraying that some injury might reasonably have been expected, for the trusses in many cases were embedded in a cast of lime. No damage, however, was noted, and the orchard was remarkably free both from apple aphides and apple suckers which were present in abundance in the unsprayed orchard. There is some reason to suppose that the sprayed orchard would in any case have been somewhat cleaner than the unsprayed owing to work carried out the previous year, but the marked difference between the two cannot wholly be attributed to this, and it is believed that the lime washing was in the main responsible.

Case II.—An apple orchard was sprayed during March and April with a "self-boiled" lime-sulphur wash, the ingredients being in the proportions of 1 lb. sulphur, 5 lb. lime, 10 gal. of water.

The last section was not sprayed until the third week in April, when the blossom was in truss and about to open. This section was very free from apple aphides and apple suckers and produced the heaviest crop of apples. Further, it was noted that the foliage remained active unusually late in the autumn.

On the other hand the sections of the orchard which were first sprayed were severely attacked by apple aphides and lost their foliage, which was much injured, comparatively early in the autumn.

Case III.—A damson orchard was sprayed between 10th February and 7th March with a mixture of lime, water-glass and salt (lime 1 cwt., water-glass 5 lb., salt 20 lb., and water 100 gal.)

The orchard was treated in sections which may be indicated as A,B,C,D. On section A there was a severe aphis attack and little fruit was obtained. Sections B and C were less damaged, and the latter produced a fair crop. Section D was sprayed during the week ending 7th March, by which date the condition of the trees was so advanced that injury from the treatment was feared. No damage, however, could subsequently be traced, and section D remained free from aphis attack and produced a very heavy crop.

DISCUSSION.

The above notes were made in commercial orchards which could not be kept under the close supervision possible in an experiment station, and they therefore lack many of the detailed observations which are usually desirable. At the same time in each case there were areas which acted as controls, and it seems permissible to draw certain conclusions.

In the first place, it would appear that an effective control as regards aphides was obtained whenever the trees were sprayed at a very late period—in fact, shortly before the blossom opened. Secondly, this late spraying caused no damage whatever to the foliage and blossom, though previously, from their advanced condition, some injury was anticipated. These conclusions apply equally to the apples and damsons, for the condition of the blossom at the dates of spraying was approximately the same in each case.

Finally, the sprays which produced these results differ materially in composition and need more detailed consideration. That used in Case I contained a very high percentage of lime with the addition of boiled lime-sulphur solution—that is to say, a solution containing various chemical compounds of lime and sulphur, some of which are supposed to have a definite action on certain insects—notably, scale insects. In Case II. a "self-boiled" lime sulphur was used. This wash differs from boiled lime sulphur in that the entire heat required for its manufacture is produced by the lime when it is slaked and no fire is used to prolong the boiling. When made under ideal conditions it is believed that the sulphur is only reduced to a very fine state of division and that little of it enters into chemical

combination with the lime. It differs radically, therefore, from boiled lime-sulphur, in which all the sulphur is combined with lime. In the formula given, however, there is a great excess of lime as compared with more usual formulæ for the preparation of this wash, and it is possible that a considerable proportion of the sulphur may have combined with lime. It would be unwise, therefore, to suggest the final constituents of the wash used, but it is evident that there must have been a great excess of free lime. The wash, however, was evidently "thinner" than those employed in Cases I and III.

In Case III., though the details are a little uncertain, it appears that a thick lime-wash was used with the addition of salt and water-glass. The action of the two latter substances is uncertain, but from some experiments it would appear that the salt may have some insecticidal properties. The water-glass, however, is only supposed to assist the lime in adhering to the trees, a contention with which all will not agree.

Comparing the three different washes which, in spite of their difference in composition, seem to have had much the same result, it appears evident that their insecticidal action must have been due primarily to their mechanical or "covering" properties. It would be unwise to speculate as to whether this action was exerted on the eggs of the aphides or on the newly-emerged insect, but in either case there seems no doubt that the more nearly the time of treatment approaches the hatching period of the insect the less important is the exact composition of the lime-wash and also the greater the chance of success.—JOUR. OF THE BD. OF AGRIC.

AGRICULTURE IN INDIA.

The long-looked for report on agriculture in India by MR. JAMES MACKENNA, I.C.S., has been published. SIR ROBERT CARLYLE, lately member in charge of the Revenue and Agriculture Department, in a foreword writes: —"MR. MACKENNA'S book brings out very clearly that although a certain amount of work, spasmodic and intermittent in character, was done before 1905, it is only within the last ten years that scientific agriculture has been seriously taken up in India. Ten years ago LORD CURZON, greatly assisted by SIR EDWARD LAW and SIR DENZIL IBBETSON, organised the department on its present lines, and although a great deal of spade work had to be done an excellent beginning has been made, and results of real value have already within this short period been achieved. The band of zealous workers who labour to benefit the people of India have before them great opportunities, and if the work so well begun be steadily continued an economic revolution should within the next twenty years be effected in this country, especially if the co-operative organization be utilized to the full in making known the results of research and experiment."

MR. MACKENNA in concluding his report writes:—The decade to which this review refers has been marked by an organised and systematic effort to improve the agriculture of India. The labours of earlier years were spasmodic and disconnected, and left little impression on the general agricultural condition of the country. Scientific workers were few. Their work was not co-ordinated and they received little encouragement either from officials or from the cultivators in whose interests they were working. Their efforts were viewed at best with sympathetic toleration or amused unbelief. But all this is now changed. The agricultural departments are now regarded as an integral and important part of the administration. The few European and Indian workers of 1905—158 in all—now number 866. Their labours are concentrated and co-ordinated. They now work on general schemes of development. Farms and demonstration plots, formerly scattered and disconnected, have increased from 35 to 374, and work on them is concentrated

on the main problems, and not dissipated as used to be the case over a number of subsidiary and unimportant enquiries. As a result the department can claim credit for a great advance in general agricultural practice. Cultural and manurial problems have in many cases been solved. Local machines have been improved and adapted, or better implements introduced. Real and substantial work has been done on the improvement of such important crops, as wheat, cotton, rice, sugarcane and tobacco. The general principles of crop improvement have naturally been dealt with first. But given more men and more money all the crops of India will be taken up. Money spent on agriculture is a good investment, but material results are difficult to gauge. Many factors have to be considered. A whole industry threatened by destruction may be saved by the discovery and application of preventive and protective methods. The treatment of the palm industry and arecanut industry of Madras and the protection of the potato crop of Patna are illustrations of this kind. Again, there are the direct gains following the introduction of new or improved crops, implements, well-boring and improved methods of cultivation. We may at a conservative estimate claim that the increase to the value of the agricultural products of India as a result of the labours of its agricultural departments is already about 3½ crores of rupees annually, or over £2,300,000. This is the result of only ten years' work, and it must be remembered that every year will show a progressive increase. On the debit side we have an annual expenditure on agriculture which has risen from Rs. 881,124 or £58,742 in 1904–05 to Rs. 5,130,652 or £342,043 in 1913–14.

ECONOMIC PROGRESS.

But the progress of the past decade has been more than merely material. A mutual understanding and friendship has grown up between the officers of the department and the cultivators. The former have long ago given up the idea that the East has nothing to teach the West. They have found that the only way to real progress is a due appreciation of local conditions and difficulties based on an accurate study of indigenous methods and a sympathetic co-operation with the cultivator: without this they labour in vain. Agricultural development cannot be fostered by compulsion or force. The adoption of the methods recommended is entirely optional. The cultivator need not take them up unless he wants to. He certainly will not do so unless he is convinced that they are better than his own. The days of suspicion and mistrust are, however, gradually passing away, and with the cordial and increasing co-operation of the cultivator an era of real progress has begun. But if we are to influence to any extent the vast agriculture of India some arrangement must be devised to deal with large bodies of cultivators as it is an economy of time to deal with a group of people rather than with single individuals. The physical capacity of members of the agricultural department has its limits as we have seen. The stages of their work are research in the laboratory of the field experiment on a field scale, demonstration on demonstration farms, and multiplication of seed on seed farms for distribution. But it is clear that direct distribution to individual cultivators is much less efficient than distribution to a group of cultivators or a whole village. In the former case control would be difficult if not impossible, and the improvised seed would rapidly disappear. In the latter, the new seed can be concentrated, controlled, and established in a definite area.

CO-OPERATION.

The decade which has witnessed this striking improvement in agriculture has also seen the rapid growth of the co-operative credit movement that great factor in all schemes of economic development. It is a happy omen for India that the two lines of development should have come into prominence simultaneously. By the establishment of the co-operative

movement, the propagandist work of the agricultural department has been immensely simplified. Improvements can be taken at once to a group of cultivators bound together by common interests instead of to isolated individuals, working selfishly. By the provision of credit, improved methods, expensive though they be, have been brought within the reach of the small cultivator, and by co-operation facilities for the more favourable disposal of his produce have also been provided. The small cultivator is lifted out of his narrow and restricted surroundings, and brought into direct touch with outside markets. Co-operation must be the bond between the cultivator and the department, between the cultivator and the market, between the cultivator and the large body of well-to-do Indians whose sympathy and interest, prior to the advent of co-operation, found an outlet in agricultural associations. Co-operation and sympathy must be the driving force all along the line. There must be less talk and more work, and the dignity of labour must be recognized. All are working for a common cause to improve the position of the individual cultivator, and to increase the material wealth of India. The economic and social regeneration of India lies in the co-operative development of her agriculture and her industries.—INDIAN AGRICULTURIST.

THE NEED FOR DESTROYING WEEDS.

Closely connected with the question of pure seeds is that of foul land, and the Board desire to call the special attention of farmers to the great need for combating weeds, which are usually responsible for great loss in the yields of crops. On a properly weeded area the crop may be double that on an unweeded area; e.g., in one case mangolds, grown under otherwise exactly similar conditions on the same field, yielded 37¼ tons per acre where two hoeings were given, and only 16¼ tons where there was no weeding after singling.

Further, a careful estimate has led to the conclusion that the annual loss actually due to the presence of weeds, and to the increased cultivations, etc., necessary to keep them in abeyance, amounts to about 20*s*. per acre in the case of root crops, 10*s*. per acre in the case of cereal, pulse, and other arable crops, 10*s*. on permanent grass, and 5*s*. on rotation grasses, etc., or about 16½ millions sterling per annum.

In this connection it may be remarked that in a Memorandum issued last year by the Farmers' Club it is observed that, "The biggest waste in agriculture is caused by weeds. As a rule, weeds are permitted by bad farmers only, and a determined attempt, notwithstanding all difficulties, should be made to get rid of the weeds so that the yield per acre of the crops we grow may attain the highest standard."

The general means available in normal years for the destruction of weeds are detailed in Leaflet No. 112 *(Weeds and their Suppression)*. In view of the fact that a larger acreage than usual of cereal crops was grown last year, and is likely to be harvested in 1916, special precautions should be taken to prevent weeds getting the upper hand. Apart from mechanical means of destroying weeds usually practised, several points are especially deserving of notice:—

(1) Seeding of all weeds should be prevented by all possible means.

(2) All perennial weeds should be cut down frequently to exhaust the suppliers of food stored up in their roots, and prevent storage of further supplies.

(3) An endeavour should be made to prevent weed seeds separated out in the course of threshing and winnowing and the refuse seeds from haylofts from again reaching the fields. Wherever possible these should be burnt.

Farmyard manure, believed to contain weed seeds in any quantity, should be allowed to rot well before application to the land. Many weed seeds may be present when meadow hay and chaff (barren glumes) of oats are fed to stock.

(4) In certain cases, where hand-hoeing is largely practised, corn crops may usefully be drilled in rows wide enough apart to permit of horse-hoeing, say 8 in. to 9 in. apart. This is especially useful in the case of spring-sown corn.

(5) Where horse-hoeing cannot be practised, the wetter the climate, or the more the land is subject to the growth of annual weeds, the closer the drill coulters should be set. When weeds are plentiful it is advisable immediately after harvest to disc or lightly scarify the surface, with a view to encouraging the germination of annual weeds. These should afterwards be ploughed down.

(6) Where weeds are likely to be abundant it may also prove a good plan to sow part of the root "break" with a vetch mixture in autumn. This would not only "smother" out weeds but reduce the labour bill for roots.

Under the Norfolk four-course rotation the area devoted to roots imposes a severe strain on labour, even in normal times. At the present time, all indications point to the necessity for modifying the usual practice. It is well known that success in root-growing and the welfare of the crops that follow depend largely on careful, thorough, and persistent cultivation of the root "break." It is desirable, therefore, that farmers should adopt every practicable means of suppressing weeds at all stages of the rotation, as for example, by the growth of heavy corn crops, and they should include in the root area such crops as will suppress weeds, save labour, and provide suitable supplementary keep for stock in winter.

LABOUR.

During the past year, no doubt largely owing to shortage of labour, weeds were unusually plentiful in many districts.

The shortage in manual labour may largely be met in so far as the destruction of weed is concerned by the employment of women and children, working when necessary in gangs in charge of one or two older and practised hands; and of temporary workers who may be in a position to do work of this kind for short periods.—JOUR. OF THE BD. OF AGRIC.

ERADICATION OF FERNS FROM PASTURE LANDS.

H. R. COX.

Over 200 species of ferns are known to be native to the United States; only two of these have become serious weed pests, viz. the hay-scented fern *(Dennstaedtia punctilobula)* and the brake *(Pteris aquilina.)*

Several other species are sometimes annoying, but they occur largely in low and moist places and do not give much trouble on good pasture land. They are principally the cinnamon fern *(Osmunda cinnamomea)*, the marsh fern (*Orthopteris thelypteris*), and the sensitive fern (*Onoclea sensibilis*). The two first species are troublesome in the hill country of the North-eastern States and the higher mountain country further south. On the Pacific coast the chief fern weed is *Pteris aquilina.*

This bulletin deals with the fern problem of the Eastern States. Although the experiments here recorded were made with *Dennstaedtia punctilobula*,

there is no doubt that the treatment found most effective with that species would apply equally well to *Pteris aquilina*. Both kinds are perennials, with running root stocks more or less parallel to the soil surface.

In most parts of the East where the ferns are weeds the land is so steep and rocky that cultivation is not practicable. It has been found that the cutting off of the tops close to the soil surface twice a year for two years will kill out nearly all of the ferns. The best times to do cutting are just previous to spring, or about the middle of June, and the middle of August in southern New York

Experiments were made in 1912 and 1913 to test the efficacy of spraying as compared with cutting and to learn the best methods of obtaining a stand of grass and clover on the fern-infested area. The spray materials used were solutions of salt, arsenite of soda and iron sulphate. These substances were used in quantities of equal value.

Of these three compounds, salt proved to be the best. The iron sulphate was ineffective; arsenite of soda was effective, but from its poisonous character, its use involved some risk to men and animals; further, except in the large centres it is difficult to obtain. The quantity of salt required to the acre depends on the thickness of the fern; 200 lb. per acre is usually ample, 1 lb. of salt being used to about 1½ quarts of water. A man with a knapsack sprayer ought to cover about 5 acres a day. The cost of spraying with salt is $1·05 per acre for each application, not including the cost of hauling the materials. Three sprayings a year seem to be about as effective as four, and are to be recommended.

Cutting the ferns is usually a cheaper method than spraying (a man cuts about 2½ acres a day and the labour is the only expense incurred); further a good growth of young grass and clover may be obtained, which contributes to the reduction of the subsequent development of the number of ferns. Cutting is therefore to be recommended in preference to spraying in most situations, but if the land is very stony, spraying may be the best method. It was found that scattering seed on the patches where ferns had grown was the most important means of getting a stand of grass and clover, and that liming and fertilising in addition to seeding were of considerable benefit.

—BULL INT. INST. OF AGRIC.

LUCERNE IN DELAWARE.

A. E. GRANTHAM.

This bulletin (Delaware Stn. Bull. 110) briefly discusses methods of production and the value of the crop for various purposes, suggests suitable rotations, and gives results of fertilizer experiments with alfalfa.

The data show that higher yields of hay followed the use of 2,000 lb. of burnt lime per acre than of either 1,000 or 4,000 lb., and that when acid phosphate was used singly or in combination with other fertilizers the increase from the use of lime was not so great as where phosphoric acid was not applied. "The plats receiving nitrogen alone and nitrogen and potash were a trifle less favourably located, and while the stand of alfalfa was good, the yield is perhaps a little less than it should be. Thus nitrogen alone produced a little less than the uninoculated check; nitrogen and potash without lime yielded about the same as the check. The low yields from these plats might be considered in error if it were not for the poor showing nitrogen and potash made in other combinations. Where nitrogen was used in connection with phosphoric acid and potash and not limed, the gain due nitrogen was zero.

Where the above combinations were used with lime, the gain due nitrogen was but 40 lb. Where nitrogen was used with phosphoric acid and unlimed, as against phosphoric acid alone, the gain due nitrogen was but 130 lb. Potash behaves similarly to nitrogen, although the gain is more than from nitrogen. Where potash is used with nitrogen combined, as compared with nitrogen alone, the gain due potash is only 120 lb. The combination of phosphoric acid and potash unlimed, as compared with phosphoric acid alone, gives an increase of 400 lb. due to potash. Where nitrogen, phosphoric acid, and potash were used together and unlimed, as compared with nitrogen and phosphoric acid, the gain due potash is 270 lb. If lime is added to both of the above combinations, the increase from potash is 560 lb.

"Phosphoric acid and lime seem to be most effective in increasing the yield . . . In the combination of nitrogen and phosphoric acid, unlimed, phosphoric acid gives a gain of 1,930 lb. over nitrogen alone. With nitrogen and potash, phosphoric acid, unlimed, gives an increase of 2,080 lb. over nitrogen and potash alone; when lime is added to both of the above combinations the increase due to phosphoric acid is 1,000 lb.

"Lime shows a marked effect in every case, except. . . .when phosphoric acid and manure were used. Phosphoric acid used with and without lime gave a difference in favour of lime of 380 lb. per acre. Where lime was used with nitrogen as against nitrogen alone the gain due lime was 1,920 lb. The effect of phosphoric acid is seen in the combination of nitrogen and phosphoric acid as against this with lime. Here the lime made an increase of only 350 lb. per acre. Nitrogen and potash combined, with and without lime, gave an increase of 1,720 lb. due to lime. Where nitrogen and phosphoric acid were combined as against nitrogen, phosphoric acid, and lime the latter combination gave an increase of only 600 lb. On the plat where all three elements were combined with and without lime the lime made an increase in yield of 640 lb.

"Wh re manure was applied lime made a very small increase in yield of hay per acre. In combination with 5 tons of manure lime made an increase of 140 lb. per acre; with 10 tons of manure 280 lb. increase was made. The reason for lime failing to show much effect is probably due to the fact that manure is often alkaline in reaction, thus supplanting the lime in sweetening the soil, or, if the soil lacks sufficient lime as direct plant food for the alfalfa, the soluble lime in the manure may take the place of the applied lime, thus accounting for the poor showing of the commercial lime.

"Inoculation gave an increase in the yield of hay of 1,360 lb. over no treatment."

The results of co-operative experiments with farmers throughout the State were similar to those secured in the station fields.—EXPT. STN. REC.

VISIT TO A JAFFNA FARM.

The term "farm" as used in S. India and North Ceylon signifies a plantation of mixed crops consisting chiefly of annuals, and cultivated in a systematic manner as regards the relation of the crops to each other and also as regards tillage and fertilising.

Of this character is the farm owned by MUDALIYAR MUTTUWELLOPILLAI at Vallygamam North and called "Intanai" about 5 miles from Jaffna, which the writer had the pleasure of visiting on the first of March last.

The entire area is 100 acres in extent and is divided by the railway line to Kankesanturai into two equal parts.

Irrigation of the cultivated area is carried out by means of two six-inch tubular pumps driven by an oil engine. With the exception of the engine the entire plant has been designed and constructed by MR. MUTTUWELLOPILLAI himself, the water being raised from a large well. By this means from 9 to 10 thousand gallons of water are brought up per hour for which only 3½ to 4 Brake Horse Power is required for a head of 25 feet.

The area under tobacco is about 12 acres, another 30 acres being under plantains, manioc and chillies, while other crops raised include Kurakkan *(Elcusine coracana)*, Sami *(Panicum miliare)*, gingelly *(Sesamum indicum)* and green gram *(Phaseolus radiatus)*. There are also about 30 acres reserved as pasture ground while a small area is under fodder crops. Ten acres have lately been planted with coconuts cultivated on red soil under irrigation.

Chewing tobacco of excellent quality is raised on the land and 1000 leaves of average size fetch from Rs. 60 to Rs. 100.

The common measure of land is the lacham. A lacham of tobacco or garden land is equivalent to 1/16 of an acre, but in the case of paddy land only 1/24 acre. It is usually reckoned that an acre carries 4,000 tobacco plants, and the best land (such as is found at "Iritanai") can be leased for as high as Rs. 80 per annum. The standing crop will fetch as much as five or six hundred rupees per acre.

Green manuring is carried on by the application of green stuff brought on to the land. For such leguminous material Rs. 12 to Rs. 20 or more per cart load is given and the manuring of an acre of tobacco may cost Rs. 200 or more. One of the most popular and expensive leguminous manures is *Tephrosia purpurea*. People who have waste lands producing weeds suitable for manuring can get Rs. 30 or more per acre for their produce.

Plantains or Bananas can be seen growing to perfection. No more than 3 plants are allowed to each bush and 300 to 400 bushes (according to variety) go to the acre. The varieties used as fruit fetch 50 to 75 cents a bunch, but "ash" or curry plantains up to Rs. 1·25. The former are taken off the trees as soon as they are mature but while still of a green colour. A number of bunches are placed in a hole dug in the ground, overlaid with twigs and covered with soil, and smoke generated in a vessel containing dry plantain leaves and straw is blown into the hole. After two days they are taken out and are dipped in water and almost immediately the fruits turn an ivory yellow colour.

Coconuts under irrigation are doing very well.

A visit to this farm is both interesting and instructive and well worth the time expended on it. The lesson which MR. MUTTUWELLOPILLAI is teaching of industrious and intelligent cultivation, producing as it is bound to do successful results, is one which deserves close study by those who have land to cultivate. His enterprise in setting up an irrigation plant, which secures for him the maximum benefit at the minimum cost, is worthy of the highest commendation.

C. D.

One of the most striking items provided by an investigation of soil gases dealt with in the memoirs of the Department of Agriculture in India (Chemical Series, Vol. iv. No. 3) is the composition of gases in the neighbourhood of the roots of plants. The proportions of carbon dioxide found are high; but most striking of all is the low proportion of oxygen, and the presence of hydrogen, which has not hitherto been suspected under these conditions. It is stated that the diffusion of gases through soils at a depth of 12 to 15 inches is so efficient as to warrant the conclusion that cultivation of the surface soil is unnecessary for purposes of æration.—AGRICULTURAL NEWS.

MARKET RATES FOR TROPICAL PRODUCTS.

(From Lewis & Peat's Latest Monthly Prices Current.)

	QUALITY.	Quotations.
ALOES, Soccotrine cwt.	Fair to fine	70/ a 80/
Zanzibar & Hepatic ,,	Common to good	40/ a 75/
ARROWROOT (Natal) lb.	Fair to fine	3½d a 4d
BEES' WAX cwt.		
Zanzibar Yellow ,,	Slightly drossy to fair	£6 17/6 a £7 2/6
East Indian, bleached ,,	Fair to good	£8 12/6 a £8 15.
,, unbleached ,,	Dark to good genuine	£6 a £6 10/
Madagascar ,,	Dark to good palish	£6 10/ a £7 2/6
CAMPHOR, Japan lb.	Refined	1/7½ a 2.
China cwt.	Fair average quality	155/ nom.
CARDAMOMS, Tuticorin	Good to fine bold	3/6 a 4/6
per lb.	Middling lean	2 a 2.9
Malabar, Tellicherry ,,	Good to fine bold	3/6 a 4/6
Calicut ,,	Brownish	2 a 3
Mangalore ,,	Med Brown to good bold	3/ a 5/3
Ceylon, Mysore ,,	Small fair to fine plump	1/9 a 5/9
Malabar ,,	Fair to good	1/7 a 1/8
Seeds, E. I. & Ceylon ,,	Fair to good	1/9 a 1/10
Ceylon "Long Wild" ,,	Shelly to good	1/ a 1/6 nom.
CASTOR OIL, Calcutta ,,	Good 2nds	3½d
CHILLIES, Zanzibar cwt.	Dull to fine bright	110/ a 120/
Japan ,,	Fair bright small	110/ a 120/
CINCHONA BARK.—lb.	Crown, Renewed	3⅜ d a 7d
Ceylon	Org. Stem	2d a 6d
	Red Org. Stem	1⅞d a 4½d
	Renewed	3d a 5½d
	Root	1⅞d a 4d
CINNAMON, Ceylon 1sts.	Fair to fine quill	1/1 a 1/9
per lb. 2nds.	,, ,,	1 a 1/6
3rds.	,, ,,	11d a 1/4
4ths.	,, ,,	10d a 1/1
Chips.	Fair to fine bold	2¾d a 4d
CLOVES, Penang lb.	Dull to fine bright pkd.	11d a 1/2
Amboyna ,,	Dull to fine	10½d a 11d
Zanzibar ,,	Fair and fine bright	7½d a 8d
Madagascar ,,	Fair	8d
Stems ,,	Fair	2½d
COFFEE		
Ceylon Plantation cwt.	Medium to bold	Nominal
Liberian ,,	Fair to bold	,,
COCOA, Ceylon Plant. ,,	Special Marks	87/ a 92/6
	Red to good	80/ a 8.6
Native Estate ,,	Ordinary to red	57 a 87
Java and Celebes ,,	Small to good red	70 6 a 98
COLOMBO ROOT ,,	Middling to good	35/ a 40/
CROTON SEEDS, sifted ,,	Dull to fair	42/6 a 47 6
CUBEBS ,, ,,	Ord. stalky to good	150 a 170
GINGER, Bengal, rough ,,	Fair	35
Calicut, Cut A ,,	Medium to fine bold	75 a 85
B & C ,,	Small and medium	50/ a 70/
Cochin, Rough ,,	Common to fine bold	40/ a 47/6
	Small and D's	40/
Japan ,,	Unsplit	40/
GUM AMMONIACUM ,,	Ord. Blocky to fair clean	60's a 85s
ANIMI, Zanzibar	Pale and amber, str. srts	£14 10/a £16 10/
,, ,, ,, little red		£11 a £12
,,	Bean and Pea size ditto	70/ a £11
,,	Fair to good red sorts	£8 10/ a £10 10
,,	Med. and bold glassy sorts	£5 10 a £7 5
Madagascar ,,	Fair to good palish	£4 a £8
,, ,, red		£4 a £7
ARABIC, E. I. & Aden ,,	Ordinary to good pale	45/ a 55/ nom.
Turkey sorts ,,	... ...	65/ a 72.6
Ghatti ,,	Sorts to fine pale	17. a 27
Kurrachee ,,	Reddish to good pale	22/6 a 32/6 nom.
Madras ,,	Dark to fine pale	20 a 30 nom
ASSAFŒTIDA ,,	Clean fr. to gd. almonds	£7 a £9
	com. stony to good block	60s a £6
KINO lb.	Fair to fine bright	6d a 1/5
MYRRH, Aden sorts cwt.	Middling to good	50/ a 60/
Somali ,,	,, ,,	40s a 50s
OLIBANUM, drop ,,	Good to fine white	45s a 50s
,,	Middling to fair	32s 6d a 40s
pickings ,,	Low to good pale	17/6 a 30/
siftings ,,	Slightly foul to fine	20s a 30s
INDIA RUBBER lb.	Fine Para smoked sheets	2/11¾
Ceylon, Straits. ,,	Crepe ordinary to fine	3 1½
Malay Straits, etc. ,,	Fine Block	2 4½
	Scrap fair to fine	2/7
Assam ,,	Plantation	2/3
,,	Fair 11 to ord. red No. 1.	2 1
Rangoon ,,	,, ,, ,, ,,	2 1

	QUALITY.	Quotations
INDIA RUBBER lb.		
Borneo ,,	Common to good	2/
Java ,,	Good to fine red	2/2
Penang ,,	Low white to prime red	1/11 a 2/
Mozambique ,,	Fair to fine red ball	2/9
,,	Sausage, fair to good	2 8
Nyassaland ,,	Fair to fine ball	2/7
Madagascar ,,	Fr to fine pinky & white	2/1
,,	Majunga & blk coated	1.10
,,	Niggers, low to good	1/2 a 1/7
New Guinea ,,	Ordinary to fine ball	2/3 a 2/6
INDIGO, E I. Bengal ,,	Shipping mid. to gd. violet	14 6 a 15 6
,,	Consuming mid. to gd.	13 6 a 14 6
	Ordinary to middling	12 6 a 13/6
,,	Mid. to good Kurpah	8/9 a 11/
,,	Low to ordinary	6.6 a 8 6
,,	Mid. to fine Madras	4/6 a 6/
MACE, Bombay & Penang	Pale reddish to fine	2/2
per lb.	Ordinary to fair	2/ a 2/1
Java ,,	,, ,, good pale	2/ a 2/2
Bombay	Wild	5d
NUTMEGS,— lb.		
Singapore & Penang ,,	64's to 57's	1.10 a 2/
	80's	1/7
	110's	1/
NUTS, ARECA cwt.	Ordinary to fair fresh	17/6 a 20
NUX VOMICA, Cochin	Ordinary to good	24/ a 26/
per cwt. Bengal	,, ,,	22/ a 23/
Madras	,, ,,	23/ a 24/
OIL OF ANISEED lb.	Fair merchantable	3/6
CASSIA ,,	According to analysis	4/ a 4/3
LEMONGRASS oz.	Good flavour & colour	1½d
NUTMEG ,,	Dingy to white	1½d a 1¾d
CINNAMON ,,	Ordinary to fair sweet	5½d a 1s 6d
CITRONELLE lb.	Bright & good flavour	2/
ORCHELLA WEED—cwt		
Ceylon ,,	Fair	10/6
Madagascar ,,	Fair	10.6
Zanzibar ,,	Fair	10/6
PEPPER—(Black) lb.		
Alleppy & Tellicherry	Fair	8½d
Ceylon ,, ,,	Fair to fine bold heavy	8.d
Singapore ...	Fair	8½d
Acheen & W. C. Penang	Dull to fine	nom.
(White) Singapore ,,	Fair to fine	10½d
Siam ,,	Fair	10d
Penang ,,	Fair	10d
Muntok ,,	Fair	10¼d
RHUBARB, Shenzi ,,	Ordinary to good	2/3 a 3.6
Canton ,,	Ordinary to good	1/6 a 2/6
High Dried ,,	Fair to fine flat	1/2 a 1/4
	Dark to fair round	8d a 8½d
SAGO, PEARL, large—cwt	Fair to fine	24 6 a 25
medium ...	,, ,,	24 6 a 25/
small ...	,, ,,	22/ a 23/
Flour ...	Good pinky to white	18/ a 19/
SEEDLAC cwt.	Ordinary to gd. soluble	55/ a 90
SENNA, Tinnevelly lb.	Good to fine bold green	11d a 1
	Fair greenish	9d a 10d
	Common specky & small	7½d a 8d
SHELLS, M. o' PEARL		
Egyptian cwt.	Small to bold	50/ a £5 10/
Bombay ,,	,, ,,	60/ a £5 10
Mergui ,,	Chicken to bold	£6 10/ a £12
Manilla ,,	Fair to good	£6 10 a 10 10
Banda ,,	Sorts	30/
Green Snail ,,	Small to large	55/ a 75/
Japan Ear ,,	Trimmed selected small to bold	47 a £5 15
TAMARINDS, Calcutta...	Mid to fine bl'k not stony	25 a 27
per cwt. Madras	Inferior to good	Nominal
TORTOISESHELL -		
Zanzibar & Bombay lb.	Small to bold	10/ a 25/
	Pickings	5/ a 15
TURMERIC, Bengal cwt.	Fair	40
Madras ,,	Finger fair to fine bold	40 a 45
Do. ,,	Bulbs ,, ,, bright	23
Cochin ,,	Finger fair	37 6
	Bulbs ,,	22/6
VANILLOES— lb.		
Mauritius ... } 1sts	Gd. crystallized 3½a 8½ in.	7 a 12
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